START

0023056

DOI/RL-91-19
Draft C

Remedial Investigation/ Feasibility Study Work Plan for the 200-UP-2 Operable Unit, Hanford Site, Richland, Washington

9 3 1 2 6 0 1 6 3 9

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
SEP 1992
RECEIVED
EDMC

United States
Department of Energy
Richland, Washington

Approved for Public Release

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

DISCLM-4 CHP (1-91)

CONTENTS

CONTENTS (cont.)

9 2 1 2 3 0 1 7 1 2

CONTENTS (cont.)

9 3 1 2 2 0 7 1 7 3

CONTENTS (cont.)

Page

FIGURES:

CONTENTS (cont.)

CONTENTS (cont.)

Page

TABLES:

9 3 1 2 9 . 0 1 7 7 6

ACRONYMS

AAMS	aggregate area management study
AEA	Atomic Energy Act
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
CDP	common depth point
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CMS	corrective measures study
CRP	community relations plan
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
ERA	expedited response action
FFS	focused feasibility study
FS	feasibility study
GPR	ground penetrating radar
HEIS	Hanford Environmental Information System
HRS	Hazard Ranking System
HSP	health and safety plan
HSWA	Hazardous and Solid Waste Amendments
IDW	investigation derived waste
IMO	Information Management Overview
IRIS	Integrated Risk Information System
IRM	interim remedial measure
LFI	limited field investigation
MEI	maximally exposed individual
mHRS	modified Hazard Ranking System
MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NPL	National Priorities List
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RAOs	remedial action objectives
RAP	remedial action plan
RARA	Radiation Area Remedial Action
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RFI	Resource Conservation and Recovery Act facility investigation
RLS	Radionuclide Logging System
ROD	Record of Decision

9 2 1 2 9 0 1 7 3 7

ACRONYMS (cont.)

SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, or disposal
USRADS	Ultrasonic Ranging and Data System
VOA	volatile organic analysis
WAC	Washington Administrative Code
WIDS	Waste Inventory Data System

1.0 INTRODUCTION

The 200-UP-2 Operable Unit is one of two source operable units at the U Plant Aggregate Area at the Hanford Site (Figures 1-1 and 1-2). Source operable units include waste management units and unplanned release sites that are potential sources of radioactive and/or hazardous substance contamination. This work plan, the attached Quality Assurance Project Plan (QAPjP), and the U Plant Source Aggregate Area Management Study Report (AAMSR) establish the operable unit setting for conducting a remedial investigation/feasibility study (RI/FS) for the 200-UP-2 Operable Unit under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This work plan presents the background and direction for conducting Limited Field Investigations (LFIs) in the 200-UP-2 Operable Unit, which are part of the process leading to final remedy selection.

Section 1.0 of this report discusses the background, purpose, scope, and goals of the 200-UP-2 Operable Unit Work Plan. The discussion begins with a summary of the regulatory framework and the role of the work plan (Section 1.1). The specific recommendations leading into the work plan are then addressed (Section 1.2). Next, the goals (Section 1.3) and organization (Section 1.4) of the report are discussed. Finally, the quality assurance and supporting documentation are presented in Section 1.5.

1.1 REGULATORY FRAMEWORK

The 200-UP-2 Operable Unit Work Plan supports and explains field activities for LFIs at select waste management units at the 200-UP-2 Operable Unit. The work plan presents activities leading to selection of interim remedial measures (IRMs). The process began with the listing of certain areas at the Hanford Site as National Priorities List (NPL) sites. Because of the need to remediate the Hanford Site, the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Washington Department of Ecology (Ecology) was reached outlining the approach and schedule for remediation. The *Hanford Site Past-Practice Strategy* was then developed to expedite the decision-making process for initiating cleanup. The AAMSR reports were conducted to recommend follow-up investigations at waste management units. One possible path for interim decision is the LFI. The conduct of the LFI in the 200-UP-2 Operable Unit is the subject of this work plan. The following sections detail each of the steps preceding the work plan and the subsequent steps that will lead to the Record of Decision (ROD) for the operable unit.

1.1.1 The Tri-Party Agreement

Four areas of the Hanford Site (the 100, 200, 300, and 1100 Areas) have been included on the EPA's NPL under CERCLA. Figure 1-1 shows the location of these areas. Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement, Ecology et al. 1990a) and the most recent amendments, signed by Ecology, EPA, and DOE, more than 1,000 inactive waste disposal and unplanned release sites on the Hanford Site have been grouped into a number of source and groundwater operable units. These operable units contain contamination in the form of hazardous waste, radioactive/hazardous mixed waste, and other CERCLA hazardous substances. Also included in the Tri-Party Agreement are 55 Resource Conservation and Recovery Act (RCRA) treatment, storage, or disposal (TSD) facilities that will be closed or permitted to operate in accordance with RCRA regulations, under the authority of Chapter 173-303 Washington Administrative Code (WAC). Some of the TSD facilities are included in the operable units.

The Tri-Party Agreement requires that the cleanup programs at the Hanford Site integrate the requirements of CERCLA, RCRA, and Washington State's dangerous waste (the state's RCRA-equivalent) program. The EPA maintains authority for CERCLA, and Ecology implements RCRA under the authority of the state's dangerous waste program. The state has also received authorization to implement the EPA's radioactive mixed waste program. The state does not yet have authority to implement the most recent amendments to RCRA, the Hazardous and Solid Waste Amendments (HSWA); this authority remains under EPA. A comparison of CERCLA and RCRA terminology used in this work plan is provided in Table 1-1. Pursuant to the Tri-Party Agreement, the 200-UP-2 Operable Unit source is subject to CERCLA remedial action authority.

The parties to the Tri-Party Agreement have determined through experience with work plans and permit applications that the RCRA/CERCLA integration strategy must be streamlined. It was projected that the existing RI/FS and RCRA Facility Investigation/ Corrective Measures Study (RFI/CMS) investigative approaches would result in costly and time-intensive investigations of all waste management units. That is, efforts could be spent investigating waste management units with little contamination, although there were areas with greater contamination that should be cleaned up in the near future. As a result, the *Hanford Site Past-Practice Strategy* was developed to expedite the cleanup by placing more emphasis on initiating and completing waste management unit cleanup at high priority sites through interim measures. This strategy was used in the preparation of the U Plant Source AAMSR and is manifested in this work plan through the prioritization of waste management units and follow-up investigations. The *Hanford Site Past-Practice Strategy* is described in more detail in the next section.

1.1.2 Hanford Site Past-Practice Strategy

Through the experience gained to date on developing work plans and permit applications at the Hanford Site, the three parties to the Tri-Party Agreement have recognized the need for a new strategy of RCRA/CERCLA integration, in contrast to a traditional CERCLA approach to an RI/FS. The new strategy is necessary because the complexity of the Hanford Site operable units (particularly with regard to characterizing existing mixed waste and hazardous waste contamination, and the need to obtain sufficient quantities of data for a high degree of certainty in decision making) has caused unexpected growth of the schedules for investigations and in the cost for conducting the RI/FS. With a traditional CERCLA approach, cleanup actions would not commence until the ROD was issued following the RI/FS. This raised the concern that too much time and too large a portion of a limited budget would be spent before actual cleanup would occur. Another motivation for a new strategy was the need to coordinate past-practice investigations with RCRA closure activities since some operable units contain RCRA TSD facilities.

In response to the above concerns, the three parties have decided to manage and implement all past-practice investigations under one characterization and remediation strategy, regardless of the regulatory agency lead (as defined in the Tri-Party Agreement). To enhance the efficiency of ongoing RI/FS and RFI/CMS activities at the 200 West Area of the Hanford Site, and to expedite the ultimate goal of cleanup, more emphasis will be placed on initiating and completing waste management unit cleanup through interim actions.

This streamlined approach is described and justified in the *Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991). To implement this approach, the three parties have developed the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) for streamlining the past-practice remedial action process. This strategy provides new concepts for:

- Accelerating decision-making by maximizing the use of existing data consistent with data quality objectives.

- Undertaking expedited response actions (ERAs) and/or IRMs, as appropriate, to either remove threats to human health and welfare and the environment, or to reduce risk by reducing toxicity, mobility, or volume of contaminants.

The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) describes the concepts and framework for the RI/FS process in a manner that has a bias-for-action through optimizing the use of interim actions, culminating with decisions on final remedies on both an operable unit and U Plant Aggregate Area scale. The strategy focuses on reaching early decisions to initiate and complete cleanup projects and maximizing the use of existing data, coupled with focused short-time-frame investigations, where necessary. As more data become available on contamination problems and associated risks, the details of the longer term investigations and studies will be better defined.

The RI/FS process under this strategy is a continuum of activities whereby the effort is refined based upon knowledge gained as work progresses (the observational approach). Whereas the strategy is intended to streamline investigations and documentation to promote the use of interim actions to accelerate cleanup, it is consistent with the RI/FS and RFI/CMS processes. As stated in the EPA document, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA; Interim Final* (EPA 1988a), the objective of the RI/FS process "... is not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site." Figure 1-3 is a decision flow chart that shows the streamlined Hanford Site past-practice RI/FS process. The strategy includes three paths for interim decision-making and a final remedy-selection process for the operable unit that incorporates the three paths and integrates units not addressed in those paths. An important element of this strategy is the application of the observational approach, in which characterization data are collected concurrently with cleanup.

As shown on Figure 1-3, the three paths for interim decision-making are:

- ERA path, where an existing or near-term unacceptable health or environmental risk from a waste management unit is determined or suspected, and a rapid response is necessary to mitigate the problem

- IRM path, where existing data are sufficient to indicate that the waste management unit poses a risk through one or more pathways and additional investigations are not needed to screen the likely range of remedial alternatives for interim actions; if a determination is made that an IRM is justified, the process will proceed to select an IRM remedy, and may include a focused FS, if needed, to select a remedy

- LFI path, where minimum site data are needed to support IRMs or other decisions, and the data can be obtained in a less formal manner than that needed to support the operable unit ROD; however, regardless of the scope of the LFI, it is a part of the RI process, and not a substitute for it.

The near-term past-practice strategy for the U Plant Aggregate Area provides for ERAs, IRMs, and LFIs for individual waste management units and grouped waste management units. While these elements may mitigate specific contamination problems through interim actions, the process of final remedy selection must be completed for the 200-UP-2 Operable Unit and the 200 Areas NPL Site to reach closure. The information obtained from the LFIs and RIs may be sufficient to perform the baseline risk assessment, and to select the remedy for the operable unit. If the data are not sufficient, additional investigations and studies will be performed to the extent necessary to support the operable unit remedy selection. These investigations would be performed within the framework and process defined for RI/FS programs.

1.1.3 U Plant Aggregate Area Management Study

The U Plant Source AAMSR provided recommendations for follow-up investigations at waste management units based on the extent of available data and the apparent threat to human health and the environment. One waste management unit was recommended for an ERA where immediate action is required. Other waste management units were recommended for LFIs when more information was needed to determine if an IRM is appropriate. Still other waste management units were determined to be of low enough concern that no immediate action is required. These waste management units were recommended for RIs. Finally, some waste management units were determined to be more appropriately addressed in other programs or in conjunction with other aggregate areas.

This section summarizes the selection process and the remediation pathways recommended in the U Plant Source AAMSR. It also explains the inclusion of the 200-UP-1 Operable Unit, describes how the ERA/LFI/IRM determination relates to prioritization of field activities.

The purpose of the AAMSR was to compile and evaluate the existing body of knowledge to support the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) decision making process. A primary task in achieving this purpose was to assess each waste management unit and unplanned release within the aggregate area to determine the most expeditious path for remediation within the statutory requirements of CERCLA and RCRA. A data evaluation process has been established that uses the existing data to develop preliminary recommendations on the appropriate remediation process path for each waste management unit. This data evaluation process is a refinement of the *Hanford Site Past-Practice Strategy* (Figure 1-3) and establishes criteria for selecting appropriate *Hanford Site Past-Practice Strategy* paths (ERA; IRM; LFI; and final remedy selection) for individual waste management units and unplanned releases within the 200 Areas.

1.1.3.1 Decision-Making Criteria. In the U Plant Source AAMSR, the criteria used for selecting remediation process paths were based primarily on urgency for action and whether site data are adequate to proceed along a given path (Figure 1-4). All units and unplanned releases that are not completely addressed under other Hanford Site programs are assessed in the data evaluation process. All of the units and releases that are addressed in the data evaluation process have been initially evaluated as candidates for an ERA.

Waste management units and unplanned releases that are not recommended for an ERA continue through the data evaluation process. Waste management units continuing through the process that potentially pose a high risk (refer to Section 5.0 of the AAMSR) become candidates for an IRM. The criteria used to determine a potential for high risk, thereby indicating a high priority unit, were the Hazard Ranking System (HRS) score used for nominating waste management units for CERCLA cleanup (40 CFR 300), the modified Hazard Ranking System (mHRS) scores, surface radiation survey data, and rankings by the Environmental Protection Program (Huckfeldt 1991). Candidate IRM units that did not meet the IRM criteria were placed into the final remedy selection path. Detailed descriptions of the selection paths are provided in Sections 9.1.1 through 9.1.3 of the U Plant Source AAMSR report.

In addition to application of the criteria to determine the priority of waste management units and necessary follow-up investigations, some waste management units were allocated to different operable units. Specifically, the waste management units of Operable Unit UP-1 were re-assigned to the 200-UP-2 Operable Unit. As a result, the 200-UP-1 waste management units are covered in this work plan.

1.1.4 200-UP-2 Operable Unit Work Plan and Later Activities

The previous sections have explained the process leading up to the conduct of the work plan. This section describes how the results of the work plan will be used and the steps toward remediation succeeding the work plan.

Figure 1-5 depicts the steps leading toward remediation of waste management units at the Hanford Site according to the HSPPIS strategy. The process is shown commencing with the AAMSR and finishing with the implementation of remedial action. The following discussion describes each of the steps and sequence.

1. The remediation process is shown beginning with the AAMSR. The AAMSR includes the analysis of existing data, a preliminary conceptual model, identification of data needs, and evaluation of data adequacy. The AAMSR results in recommendations for ERA, IRM, and final remedy selection paths. In cases where there is inadequate data, an LFI is recommended so that a determination for an IRM or final remedy selection can be made. The ERA path is shown in Figure 1-5, but is not described in detail.

Upon completion of an ERA, the affected waste management unit would re-enter the decision process to determine if an IRM or Final Remedy is appropriate.

Figure 1-5 shows the decision point where the determination is made of the sufficiency of data for an IRM. In the AAMSR process, this determination was made for certain waste management units. Obtaining the necessary information to make this determination is the subject of the 200-UP-2 Operable Unit Work Plan.

2. LFI Work Plan

The 200-UP-2 Operable Unit LFI Work Plan follows the AAMSR. Its purpose is to provide the rationale and direction for collecting information at waste management units designated for LFIs. As will be described in later sections of this work plan, strategies are developed for acquiring data at representative waste management units suspected of containing more contamination than other waste management units, then using these data to aid in the characterization of other waste management units. The outcome of the work plan is a report describing how and where data will be acquired.

3. Limited Field Investigation

LFIs will follow the 200-UP-2 Operable Unit Work Plan. The field investigation will include surface sampling, drilling of boreholes, and radiological and chemical analyses. A report will be prepared compiling the results of the LFI. The results of the analyses will feed into the re-evaluation of data adequacy to make an IRM determination. If the data are inadequate, further field investigations will be conducted. If the data are adequate, a qualitative risk assessment will be performed.

4. Qualitative Risk Assessment

A qualitative risk assessment follows the determination that adequate information has been acquired to support an IRM. The qualitative risk assessment will be performed to determine if contaminant concentrations are high enough and exposure pathways exist such that interim measures are needed to remediate a waste management unit. If it is found that the risk is sufficiently low, the subject waste management units are relegated to the final remedy selection path. If the risk is considered high, then the waste management unit is assessed to determine an acceptable remedial action. Chemical concentration data collected during the LFI will be used in the qualitative risk assessment.

The remedial action evaluation is necessary to determine the appropriate technology to remediate the site on an interim basis. It may be possible to select this technology with the knowledge gained to date about the site and the performance of established technologies. If this decision is not possible, then a focused feasibility study (FFS) is needed.

5. Focused Feasibility Study

An FFS will be conducted to identify a suitable remediation technology for a waste management unit or group of similar waste management units. A FS is conducted to provide a comprehensive evaluation of technologies. In the case of an IRM, where there is the need for quick action, the feasibility study is "focused" to reach a decision more quickly. The FFS concludes with a report describing the evaluation and selection of the recommended remedial technology.

6. Interim Remedial Measure Plan

The IRM plan will succeed the FFS or the qualitative risk assessment when an FFS is unnecessary. The IRM plan describes the selected technology and its implementation. The IRM may combine similar actions at waste management units or may be developed for a single waste management unit.

7. Interim Remedial Measure Record of Decision

The IRM ROD will be a legal document describing the IRM actions and schedule produced after public comment and review and agreement by the overseeing agencies. The IRM ROD describes the context, data, need, and plan for conducting interim remedial actions. The IRM will be written and issued by the regulators. A single IRM ROD may be issued for each waste management unit, or the ROD may be consolidated for several or all waste management units. Following issuance of the ROD, the IRM will be implemented.

8. Interim Remedial Measure Implementation

The IRM will be implemented according to the description and schedule indicated in the ROD. The implementation process will include preparation of preliminary and final design documents and other supporting plans. The IRM technology will then be implemented. The technology will be assessed to ensure the IRM has been successful. Because the IRM is intended only to be an intermediate step in the overall remediation, the waste management units affected by IRMs will continue to the final remedy selection path.

9-14. Recommendations for the final remedy selection path are the third possible outcome of the AAMSR for a waste management unit. Waste management units recommended for this path generally are lower priority sites or sites where an IRM or ERA is not necessary or do not facilitate a final solution. This final RI will eventually lead to an operable unit ROD, and the implementation of an operable unit-wide remedial action.

1.2 U PLANT AGGREGATE AREA MANAGEMENT STUDY RECOMMENDATIONS

Table 1-2 summarizes the disposition of waste management units in the 200-UP-2 Operable Unit. A detailed discussion of the unit dispositions is provided in Section 9.2 of the U Plant Source AAMSR. The table lists the waste management units according to the type of study that will be conducted:

- LFI studies at high priority units
- Confirmatory sampling at high priority units
- Remedial investigation at low priority units
- Units transferred to other operable units
- Units transferred to other Hanford programs.

This work plan describes LFI and confirmatory sampling at high priority, IRM candidate sites and their associated analogous units. In some cases, closely associated low priority units will also be studied. Field work associated with RI activities at low priority sites in the 200-UP-2 Operable Unit will be addressed in later supplements to this document.

The LFIs will be conducted at the cribs, the french drains, and reverse wells. As proposed in the U Plant Source AAMSR, analog units will be selected for detailed study from these larger groups of similar units. The analog unit selection process is detailed in Section 4.2 of this work plan. Although the 241-U-361 Settling Tank was not proposed for an LFI by the AAMSR, it is being included with the crib LFI because it is a high priority unit that is closely related to the 216-U-1 and 216-U-2 Cribs.

Confirmatory sampling will be conducted at the 216-U-10 Pond and its associated ditches. Extensive radiological data are available for these sites, so a full LFI is not required before an IRM is conducted. However, a limited amount of confirmatory sampling is required to fill in the few remaining data gaps identified in the U Plant Source AAMSR.

The 207-U Retention Basin is included in this confirmatory sampling program because it is a high priority unit that is closely associated with the 216-U-14 Ditch.

All of the unplanned releases, trenches, septic tanks, and burial sites are low priority units and were recommended for study under the RI path in the U Plant Source AAMSR. These sites are not covered under the scope of this work plan and so most of them will not be discussed further. A limited number of low priority sites (2607-W5 Septic Tank and Drain Field, and Unplanned Release UN-200-W-19) are closely related to high priority waste management units and so will be studied as part of a larger LFI.

Several waste management units within the 200-UP-2 Operable Unit were excluded from the U Plant Source AAMSR remediation process path assessment. These units are generally structures that are covered under other Hanford programs or facilities that were recommended for transfer to other operable units. The U Plant Source AAMSR recommended that the 241-U-151 and the 241-U-152 Diversion Boxes be grouped with the 200-UP-3 Operable Unit. These two diversion boxes are located on the eastern edge of the 200-UP-3 Operable Unit and are historically connected with operations at the tank farm. Unplanned Release UN-200-W6 is associated with the diversion boxes and should also be moved to the 200-UP-3 Operable Unit. The 216-S-4 French Drain and the 216-S-21 Crib received wastes from the S Plant Aggregate Area and are located near related waste management units that will be addressed in the S Plant remedial activities. Similarly, the 216-Z-20 is logically associated with the Z Plant operations and will be addressed along with related Z Plant waste management units.

The 241-UX-154 Diversion Box and the 241-UX-302 Catch Tank are part of the tank waste cross-site transfer line and are likely to be operating for several years. These waste management units were, therefore, recommended for inclusion in the decontamination and decommissioning of the cross-site transfer lines and encasements after operations are discontinued. The 241-WR Vault is covered under the Hanford Surplus Facilities Program and should be closed under that program's decontamination and decommissioning schedule.

Unplanned Release UN-200-W-138 has been reassigned by the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) to the 216-U-7 French Drain and is now considered part of that waste management unit. The release occurred within the 216-U-7 French Drain and will be covered by the investigation of that facility (Ecology et al. 1992).

1.3 PROJECT GOALS

The primary goals of the LFIs in the 200-UP-2 Operable Unit are to provide sufficient information to perform qualitative risk assessments, and to select and justify IRMS. These goals must be reached for each set of analog units that are studied: the cribs, the french drains and reverse wells, and the 216-U-10 Pond and its associated ditches. This will involve identifying maximum contaminant concentrations, vertical distributions, and to a lesser extent, horizontal distributions. The data collected during the LFIs should be of sufficient quality for use in the final RI, although this is not its primary purpose.

1.4 ORGANIZATION OF THE WORK PLAN

This work plan is made up of eight sections, including this introduction. Sections 2.0 and 3.0 are summaries of data presented in the U Plant Source AAMSR. To avoid redundancy, these sections reference the AAMSR except when new data are being presented. Section 2.0 summarizes the physical and environmental setting of the area, and presents data on the history and construction of the waste management units. Section 3.0 summarizes the contaminant distribution data, the conceptual model, the potential applicable or relevant and appropriate requirements (ARARs) discussion, and the remedial action objectives presented in the AAMSR.

Section 4.0 presents the rationale for the field activities proposed in this work plan. The data gaps and data needs identified in the AAMSR are briefly summarized at the beginning of the section. The section next develops conceptual models of subsurface contaminant distribution based upon previous studies at similar waste management units. The analog unit selection criteria are also developed for each class of waste management unit. The rationale for the types, locations, and numbers of samples at each waste management unit are then presented.

Section 5.0 describes the data collection activities that will be performed at each waste management unit. The protocols and procedures for each activity are also detailed in this section.

Section 6.0 presents the remedial alternatives development, screening, and analysis. This section is an integral part of the path leading to an FFS.

Section 7.0 presents the project schedule for the work plan activities. References used in the work plan are provided in Section 8.0.

Appendix A to this work plan presents Radionuclide Logging System (RLS) gamma spectrometer data from several wells within the operable unit. Attachment 1 is the Quality Assurance Project Plan (QAPjP).

1.5 QUALITY ASSURANCE

The 200-UP-2 Operable Unit Work Plan and its supporting project plans have been developed to meet specific EPA guidelines for format and structure, within the overall quality assurance (QA) program structure mandated by the U.S. Department of Energy Order 5700.6C, Quality Assurance (DOE 1991a). All work conducted under the 200-UP-2 Operable Unit Work Plan will conform to the conditions set forth in the Tri-Party Agreement. In accordance with the Tri-Party Agreement, relevant EPA guidance documents were consulted in the preparation of the work plan, including the following:

- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988a)
- *Data Quality Objectives for Remedial Response Activities* (CDM Federal Programs Corporation 1987)
- *Superfund Exposure Assessment Manual* (EPA 1988b)
- *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A, Interim Final* (EPA 1989a)
- *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual* (EPA 1989b).
- *EPA Region 10 Supplemental Risk Assessment Guidance for Superfund* (EPA 1991)

The 200-UP-2 Operable Unit QAPjP (Attachment 1) supports the field sampling program described in Section 5.0. It defines the specific means that will be used to ensure that the sampling and analytical data obtained as part of the LFIs will effectively support the purposes of the investigation. As required by the Westinghouse Hanford QA program plan for RI/FS activities and the *Hanford Federal Facility Agreement and Consent Order*, the structure and content of the QAPP are based on *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (Stanley and Verner 1983). Where required, the QAPjP invokes appropriate procedural controls selected from those listed in the

Westinghouse Hanford QA program plan for RI/FS activities or developed to accommodate the unique needs of this investigation.

9 2 1 2 5 0 1 7 1 3

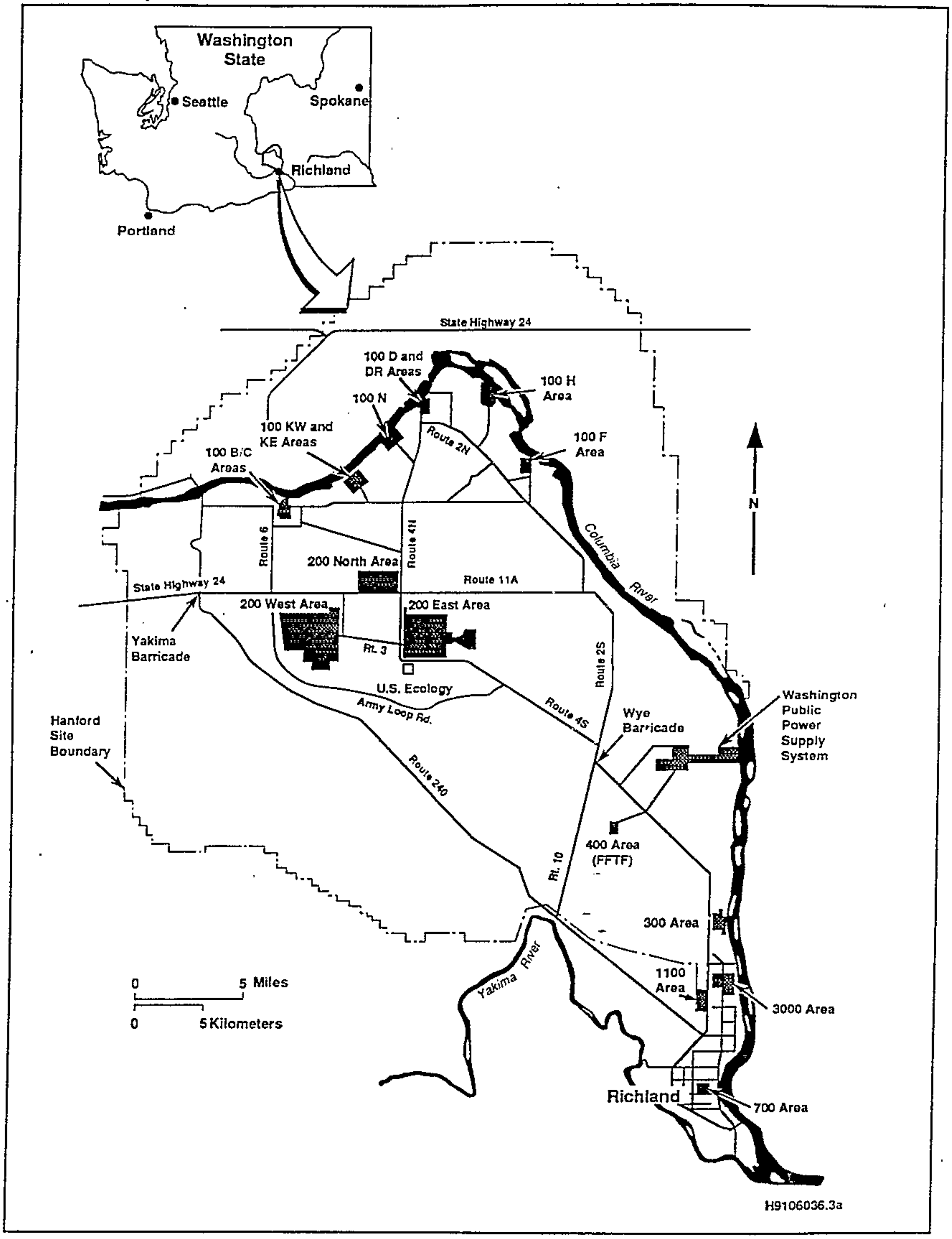


Figure 1-1. Hanford Site Map.

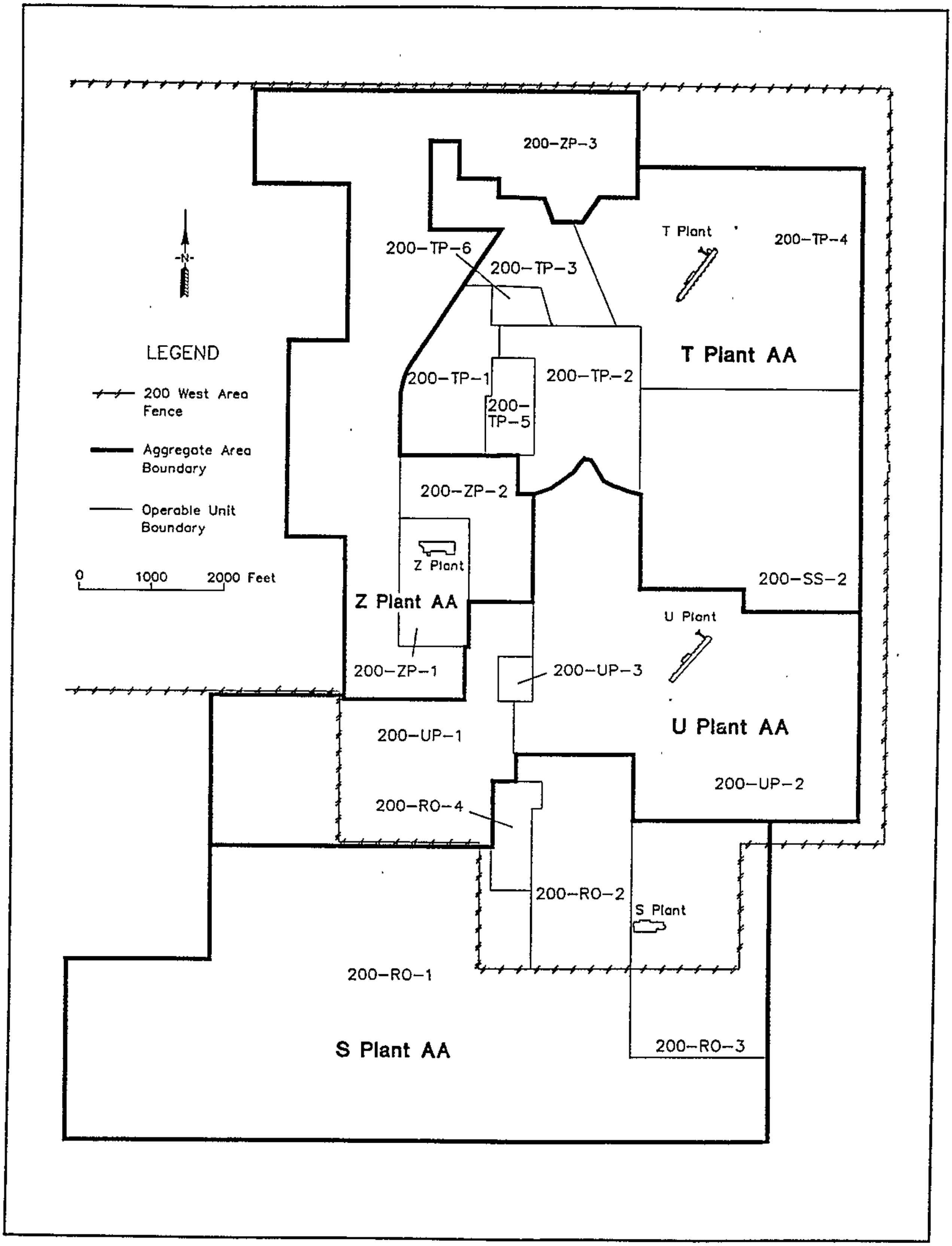


Figure 1-2. 200 West Aggregate Areas.

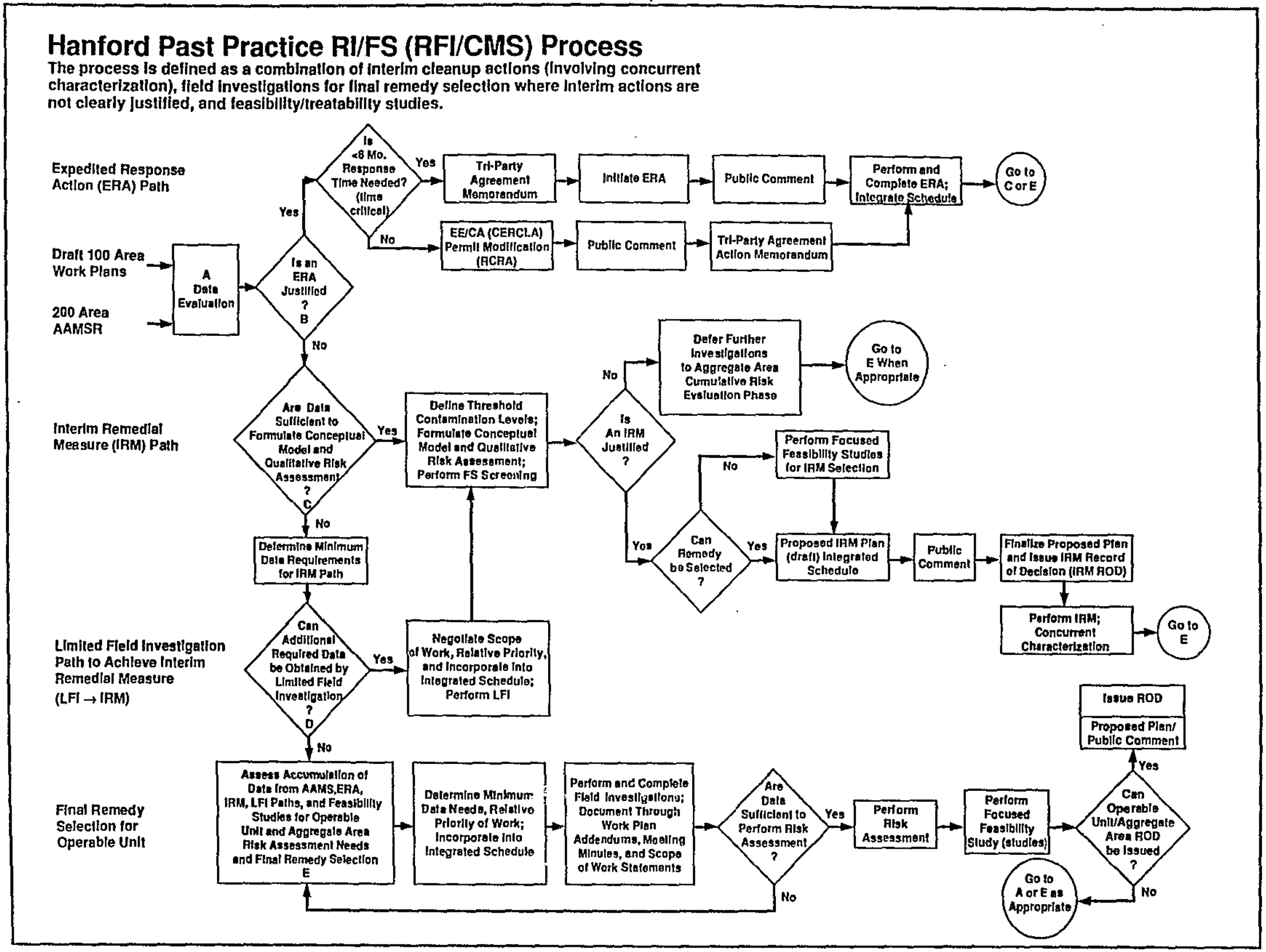


Figure 1-3. Hanford Past Practice Strategy Flow Chart (DOR/RL 1992a).

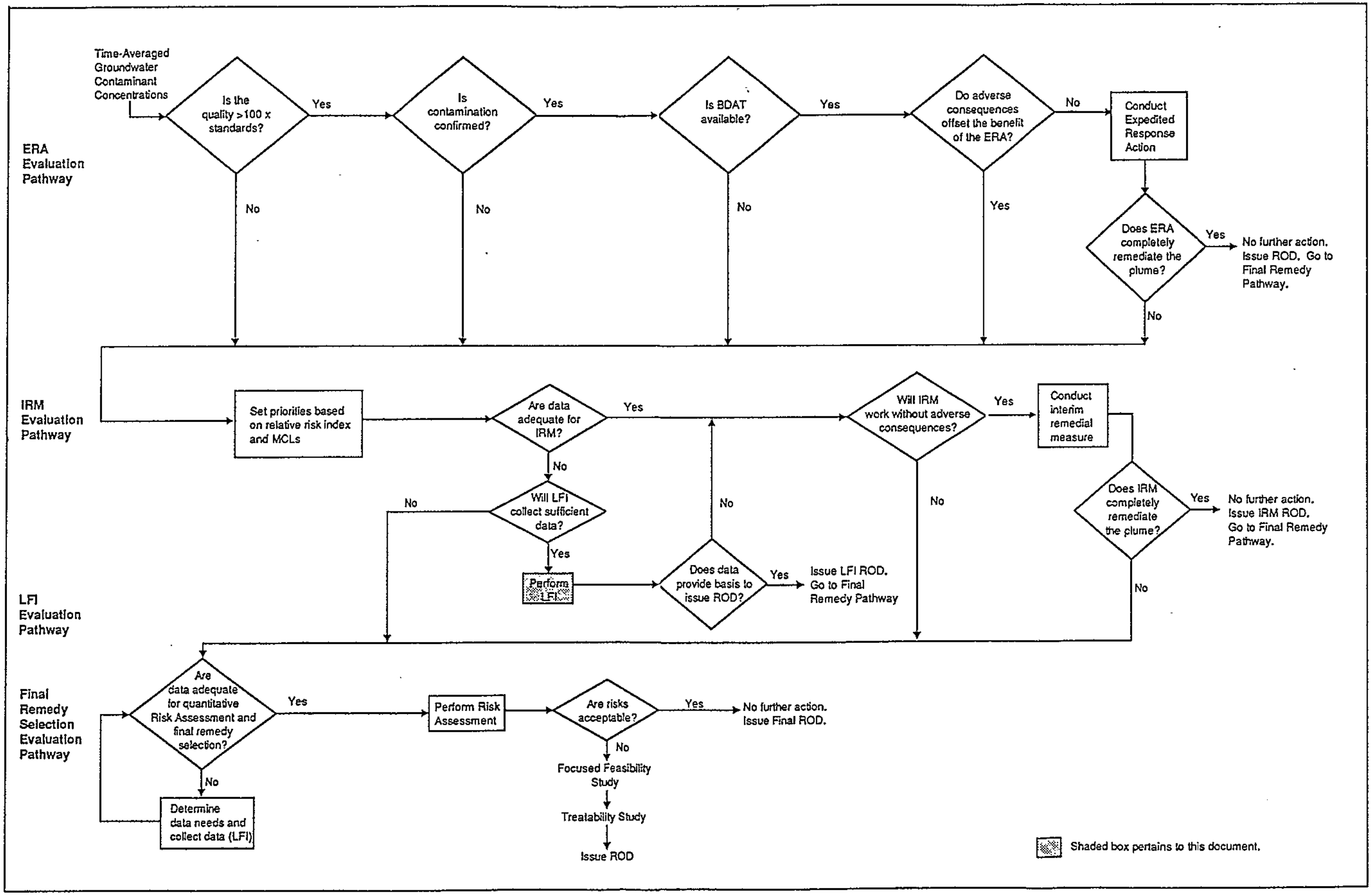


Figure 1-4. 200 Aggregate Area Management Study Data Evaluation Process.

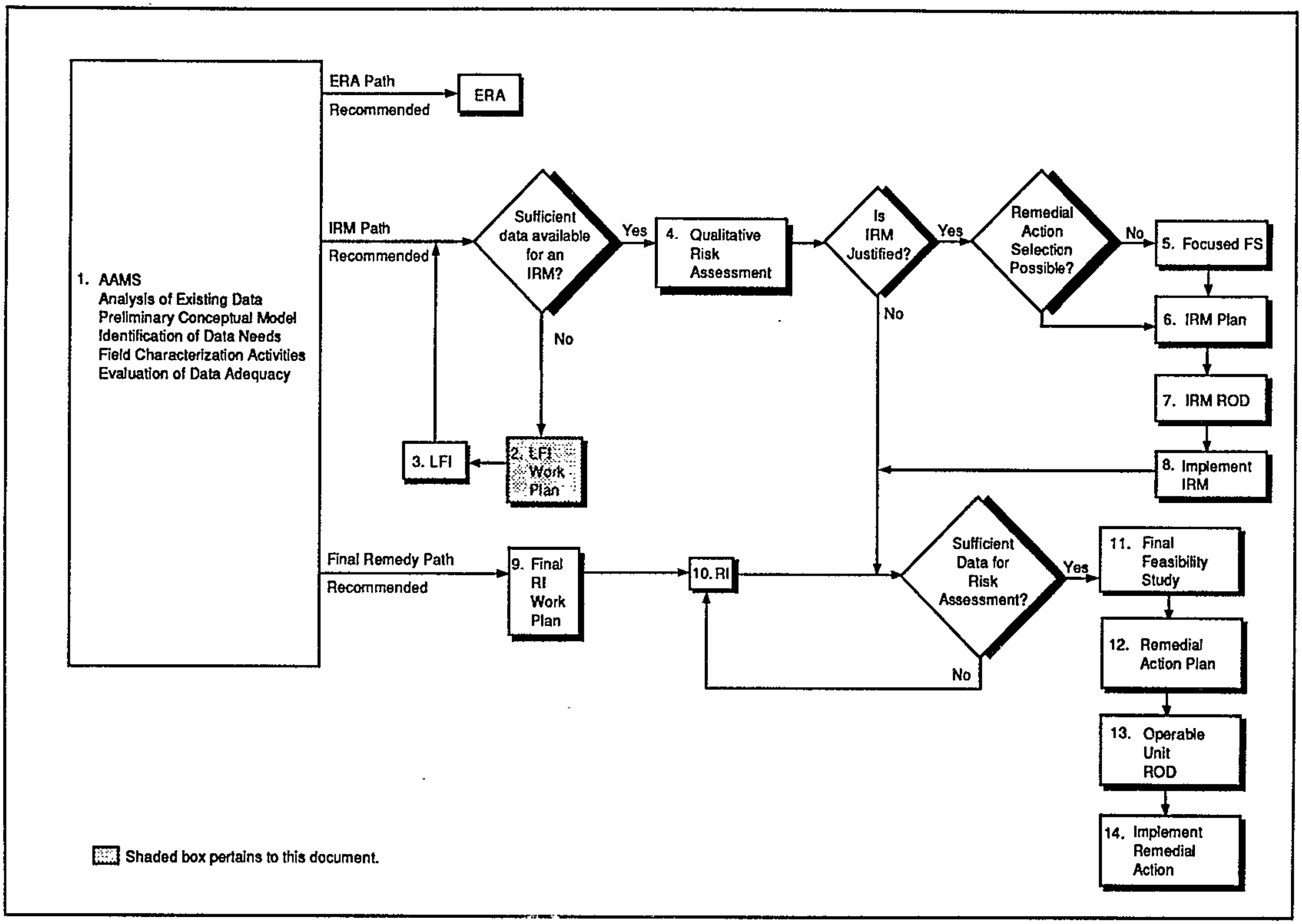


Figure 1-5. 200-UP-2 Operable Unit Work Plan Interrelationships.

Table 1-1. The Relationship Between RCRA and CERCLA Terminology Used in this Work Plan.

RCRA Terminology	CERCLA Terminology
Resource Conservation and Recovery Act Facility Investigation (RFI)	Remedial Investigation (RI)
Corrective Measures Study (CMS)	Feasibility Study (FS)
Limited Field Investigation (LFI)	Limited Field Investigation (LFI)
Focused Feasibility Study (Focused FS)	Focused Feasibility Study (Focused FS)
Expedited Response Action (ERA)	Expedited Response Action (ERA)
Interim Response Measure (IRM)	Interim Response Measure (IRM)
Proposed IRM Plan	Proposed IRM Plan
IRM Record of Decision (ROD)	IRM Record of Decision (ROD)
IRM Design Report	IRM Design Report
IRM Implementation	IRM Implementation
Proposed Corrective Action Plan	Proposed Corrective Action Plan
Corrective Action ROD	Remedial Action ROD
Corrective Action Design Report	Remedial Action Design Report
Corrective Action Implementation	Remedial Action Implementation
Corrective Action Requirement (CAR)	Applicable or Relevant and Appropriate Requirement (ARAR)

Table 1-2. Disposition of Waste Management Units in the 200-UP-2 Operable Unit. Page 1 of 2

LFI Studies at High Priority Units[1/]
216-U-1 and 216-U-2 Cribs
216-U-8 Crib
216-U-12 Crib
216-U-16 Crib
216-U-17 Crib
216-U-3 French Drain
216-U-4A French Drain
216-U-4B French Drain
216-U-7 French Drain
216-U-4 Reverse Well
241-U-361 Settling Tank
(To be studied in conjunction with 216-U-1 and 216-U-2 Cribs)
Confirmatory Sampling at High Priority Units[1/]
216-U-10 Pond
216-U-11 Trench
216-Z-1D Ditch
216-Z-11 Ditch
216-Z-19 Ditch
216-U-14 Ditch (inactive portions)
207-U Retention Basin
(To be studied in conjunction with the 216-U-14 Ditch)
Remedial Investigation at Low Priority Units
216-U-5 and 216-U-6 Trenches
216-U-13 Trench
216-U-15 Trench
2607-W-5 Septic Tank/Drain Field
2607-W-7 Septic Tank/Drain Field
2607-W-9 Septic Tank/Drain Field
Construction Surface Laydown Area
Burning Pit/Burial Ground
UN-200-W-19
UN-200-W-33
UN-200-W-39
UN-200-W-46
UN-200-W-48
UN-200-W-55
UN-200-W-60
UN-200-W-68
UN-200-W-78

Table 1-2. Disposition of Waste Management Units in the 200-UP-2 Operable Unit. Page 2 of 2

UN-200-W-86
UN-200-W-101
UN-200-W-117
UN-200-W-118
Units Transferred to Other Operable Units
241-U-151 Diversion Box
241-U-152 Diversion Box
UN-200-W6 Unplanned Release
216-S-4 French Drain
216-S-21 Crib
216-Z-20 Crib
Units Transferred to Other Hanford Programs
241-UX-154 Diversion Box
241-UX-302 Catch Tank
241-WR Vault

1/ Waste management units in these categories are being studied as part of this work plan.

9 3 1 2 3 0 1 7 3 9

2.0 BACKGROUND AND SETTING

Section 2.1 summarizes the waste management unit and unplanned release descriptions from the U Plant Source AAMSR. The physical setting of the 200-UP-2 Operable Unit, including the meteorology and geology, is summarized in Section 2.2.

2.1 WASTE MANAGEMENT UNIT DESCRIPTIONS

The waste management units within the 200-UP-2 Operable Unit were facilities designed for the storage or disposal of wastes generated by U Plant Aggregate Area operations. The primary waste generating processes within the operable unit are associated with the operation of the 221-U Building and its ancillary support facilities. Operations in the 221-U Building Complex have included uranium reclamation, uranyl nitrate calcination, and the decontamination and reclamation of process equipment. The 216-Z-1D, 216-Z-11, and 216-Z-19 Ditches and the 216-U-10 Pond have all received wastes from the plutonium processing facilities of the Z Plant Aggregate Area. The waste management units listed in Table 1-2 and shown on Plate 1 (at the end of this report) are described in Sections 2.3.2 through 2.3.10 of the U Plant Source AAMSR. Table 2-1 summarizes the physical characteristics of all the ponds, ditches, cribs, french drains, and reverse wells that are addressed as part of this LFI.

2.2 PHYSICAL SETTING

Detailed descriptions of the physiography and topography, surface hydrology, and environmental and human resources of the 200-UP-2 Operable Unit are discussed in Sections 3.1, 3.3, 3.6, and 3.7, respectively, of the U Plant Source AAMSR. This section briefly describes the meteorology, geology, and hydrogeology of the 200-UP-2 Operable Unit and presents waste management unit-specific information not found in the U Plant Source AAMSR. More detailed descriptions of the general operable unit meteorology, geology, and hydrogeology are discussed in Sections 3.2, 3.4, and 3.5, respectively, of the U Plant Source AAMSR.

The Hanford Site has a semiarid climate and has a northwest to west-northwest prevailing wind direction (Figure 2-1).

The 200-UP-2 Operable Unit is underlain by a thick sequence of unconsolidated quaternary gravels and sands with minor silt. Figure 2-2 presents a conceptual geologic and hydrogeologic column of the quaternary stratigraphy beneath the operable unit.

The vadose zone is 60 to 70 m (197 to 230 ft) thick beneath the 200-UP-2 Operable Unit. The most significant aquitard within the vadose zone is the caliche layer within the Plio-Pleistocene unit. This unit inhibits the downward flow of water and local, discontinuous perched water zones may form above it. The unconfined aquifer is within the unit E and unit A gravels of the Ringold Formation.

Figures 2-3 through 2-5 are block diagrams showing the stratigraphy beneath the 200-UP-2 Operable Unit. The waste management units which have had large liquid discharges are superimposed onto the blocks. These block diagrams are generated from a synthesis of all the well log data available for the 200-UP-2 Operable Unit. Plate 1 of this document shows some of the wells used for the diagrams. A more complete plot of the well data used is available on Plate 3 of the AAMSR. As shown on Figure 2-3, except for the eolian sands, all of the vadose zone units are laterally continuous beneath the operable unit. Figure 2-4 is drawn on top of the early "Palouse" soil. It shows that the unit is laterally continuous, but that its thickness is highly variable. Figure 2-5 is drawn on top of the Plio-Pleistocene unit. This diagram again shows that this important aquitard is continuous across the operable unit and that its upper surface is gently undulating. The surface tends to slope to the south across the operable unit and perched water should generally flow in that direction.

Stratigraphic columns that are specific to individual waste management units are shown on Figures 2-6 through 2-14. These columns also show any data that are available from gross gamma or spectral gamma logging of the wells. If contacts shown on the composite stratigraphic columns are not horizontal, this indicates that the contacts were encountered at different depths in the borings used to compile the columns. Cross sections were made beneath the 216-U-14 Ditch and the 216-Z-1D, 216-Z-11, and 216-Z-19 Ditches and are shown in Figures 2-15 and 2-16. These composite stratigraphic columns and cross sections were compiled from well logs and from structure contour and isopach maps for each facility that received large volumes of liquid waste. The wells that were used for the composites are listed on the stratigraphic column figures. The well locations are shown on Plate 1. For many of the composite stratigraphic columns, the only nearby well log data available were old drillers logs of very poor quality. In particular, the caliche layer was seldom noted in these older logs and so the graphic logs of some columns do not show caliche. This does not mean the layer is not present beneath the site, it merely indicates that it was not noted. Isopach maps drawn across the entire operable unit, using data from new borings that were logged by a geologist, indicate that the caliche layer is continuous beneath the entire area. These operable unit-wide structure contour and isopach maps were also used to construct columns in areas where there were not nearby wells. These maps are presented in Section 3.0 of the AAMSR. These figures again show that the stratigraphy is relatively uniform beneath the 200-UP-2 Operable Unit. Most importantly, the Plio-Pleistocene unit and the early "Palouse" soil occur beneath each waste management unit. The columns and cross sections are used to compare analog unit stratigraphy in Section 4.2.

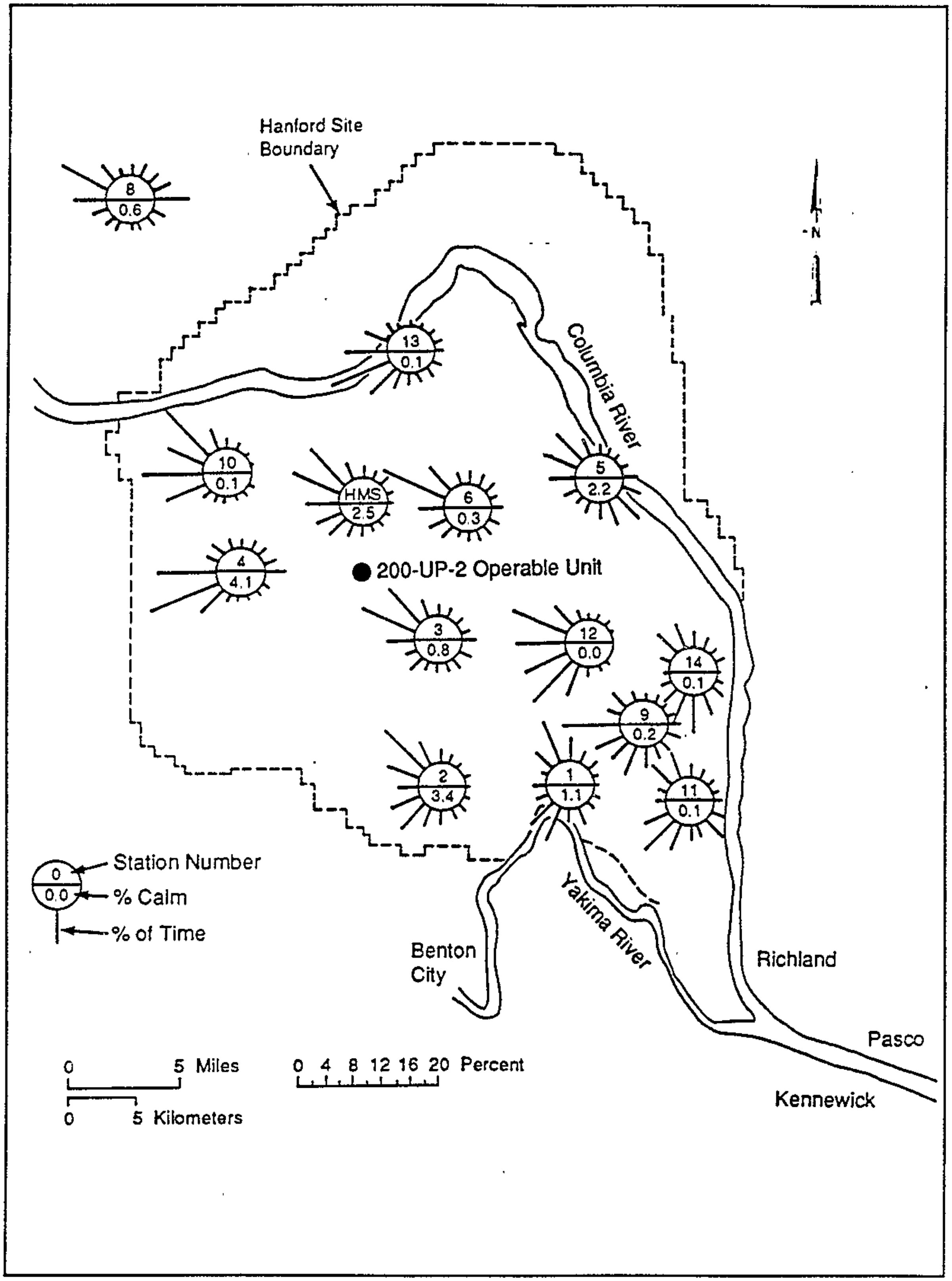


Figure 2-1. Hanford Site Wind Roses, 1979 through 1982.

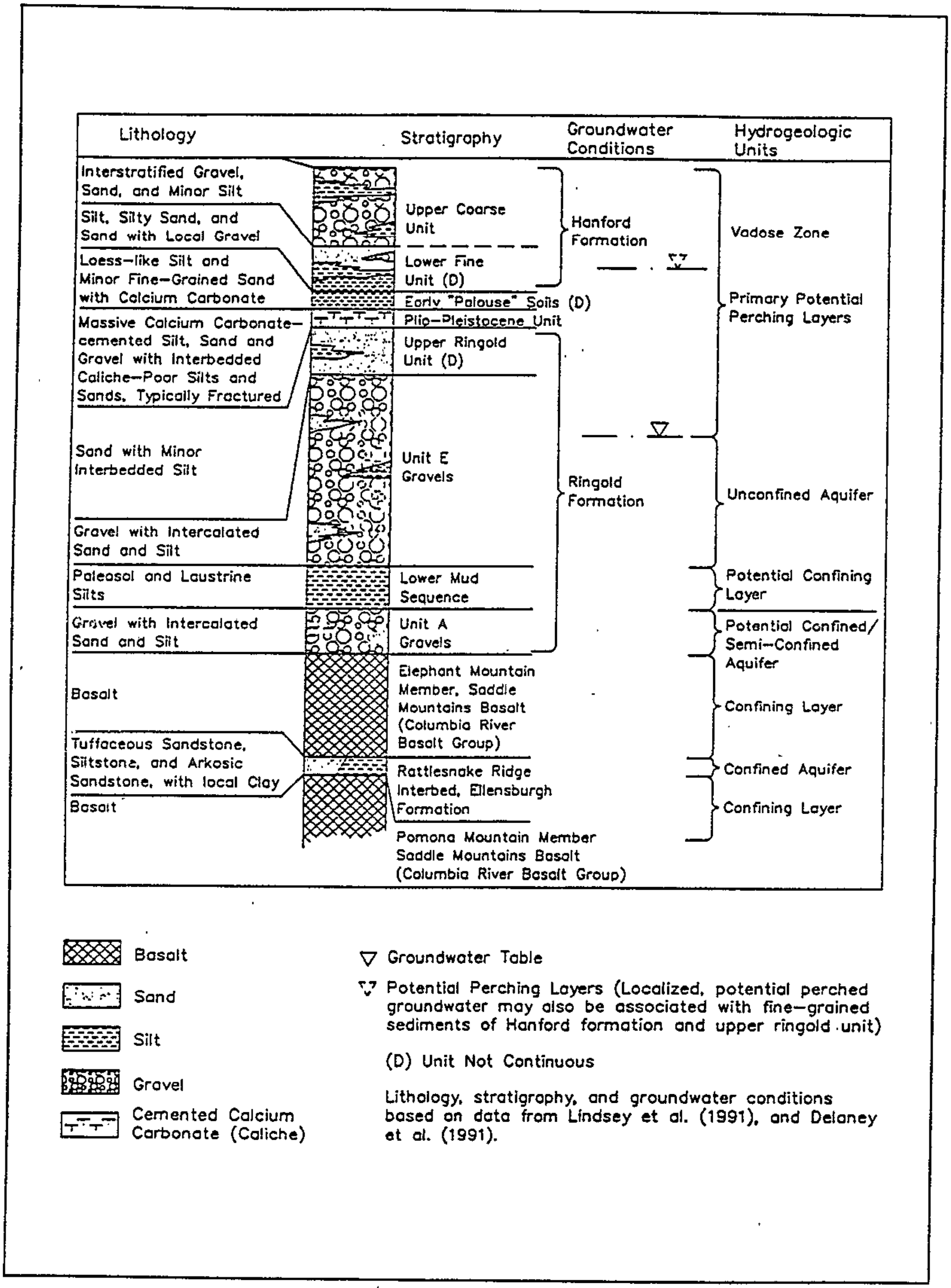


Figure 2-2. Geologic and Hydrogeologic Column for the 200-UP-2 Operable Unit.

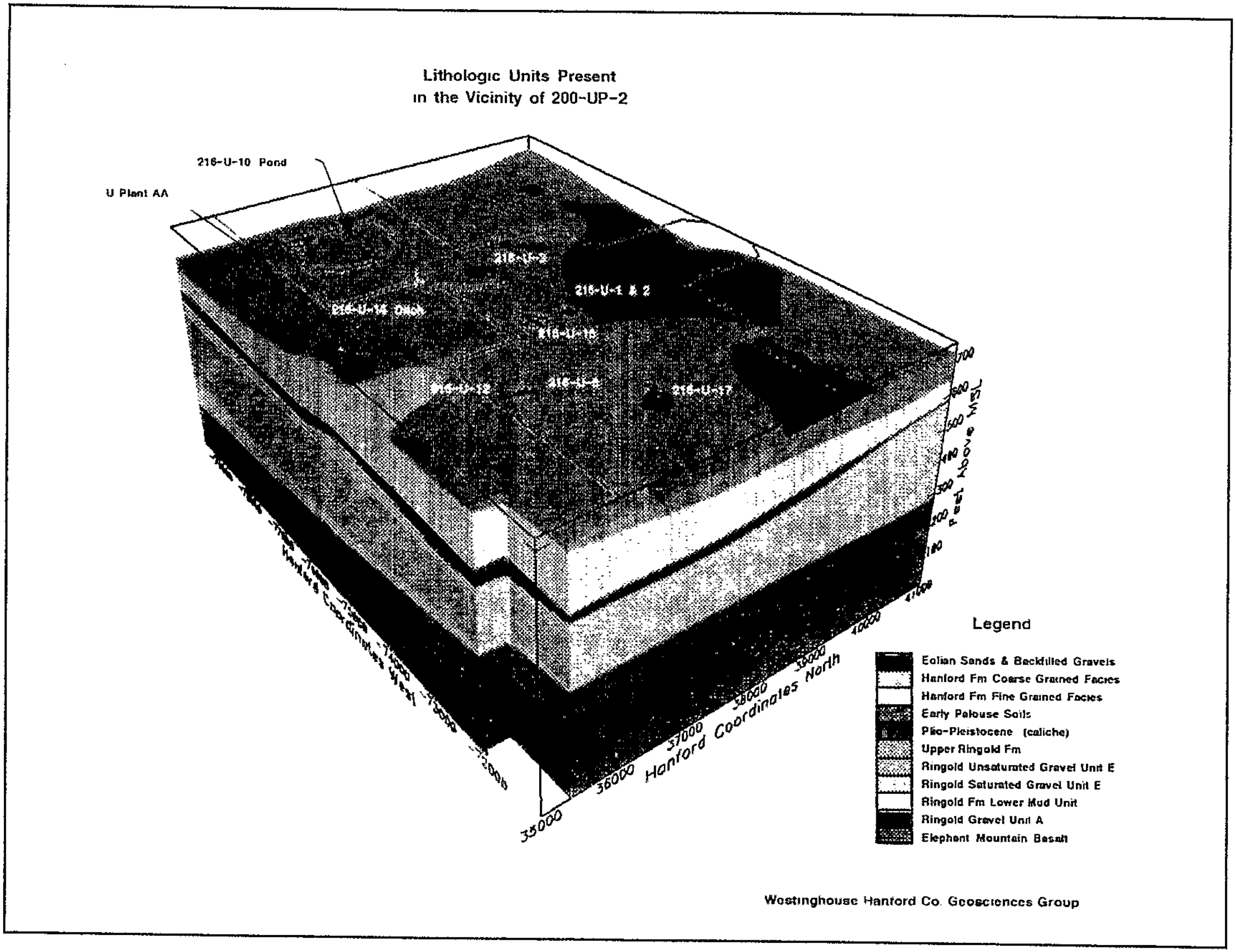


Figure 2-3. Block Diagram Showing 200-UP-2 Operable Unit Stratigraphy.

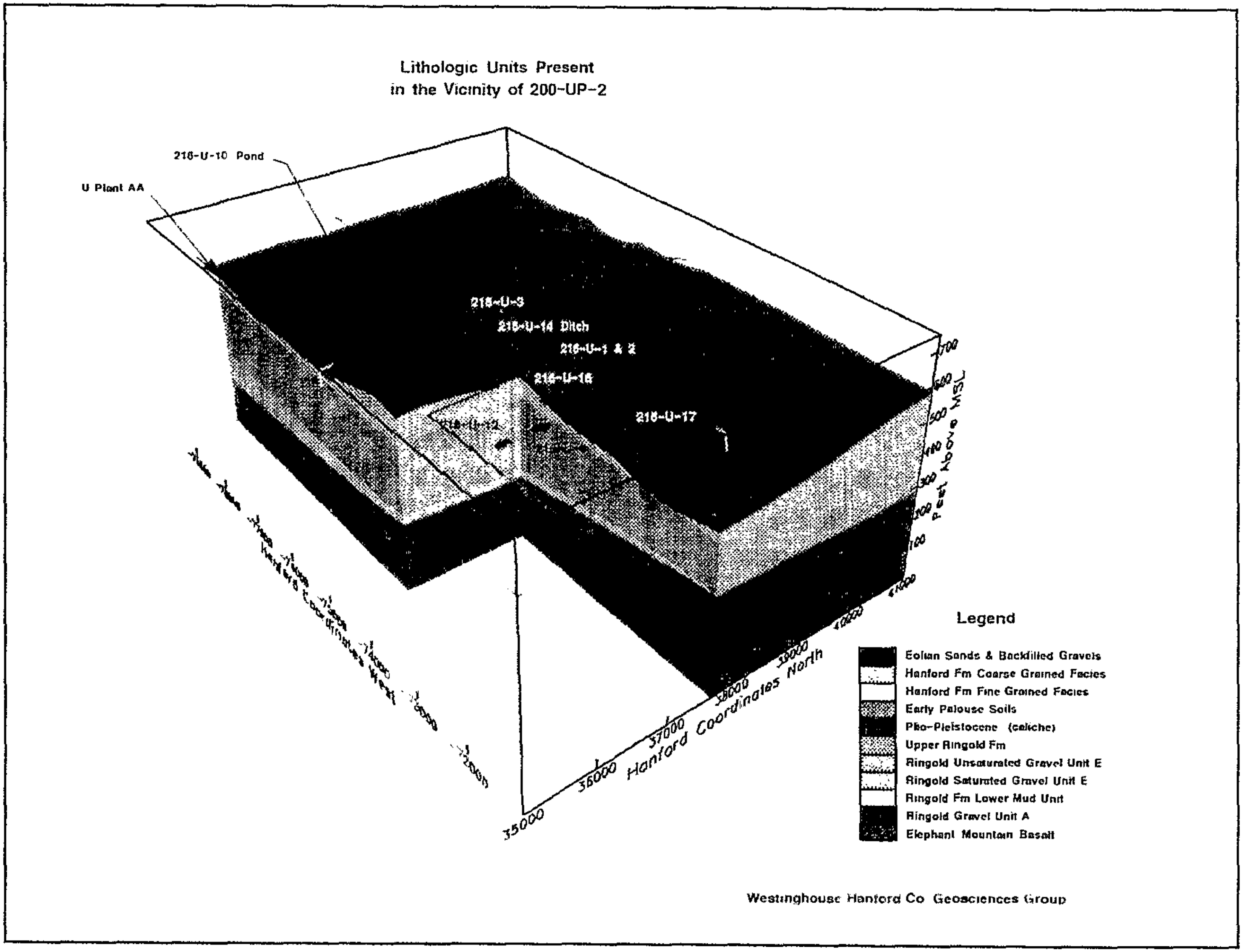


Figure 2-4. Block Diagram Showing 200-UP-2 Operable Unit Stratigraphy Below the Hanford Formation.

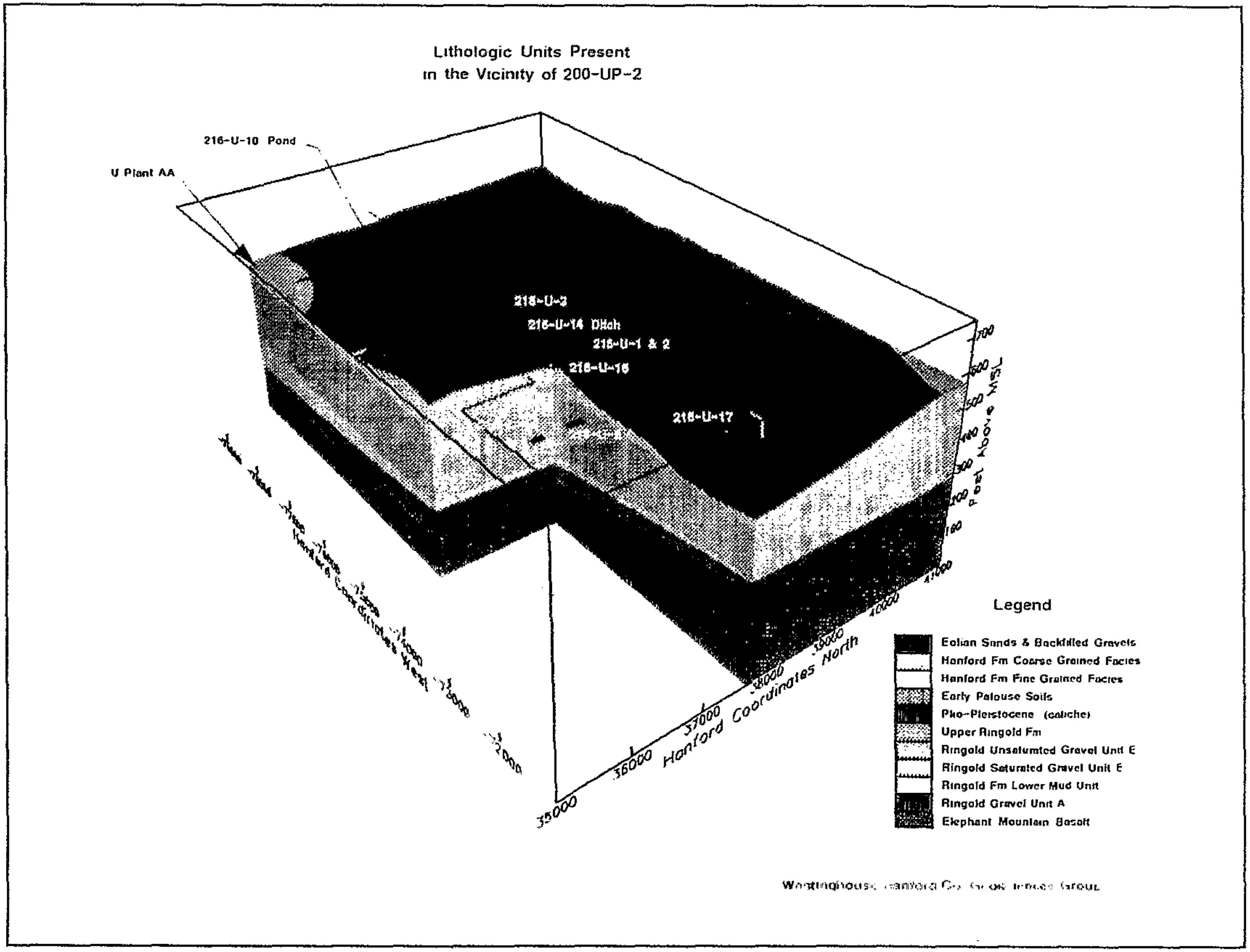


Figure 2-5. Block Diagram Showing 200-UP-2 Operable Unit Stratigraphy Below the Early "Palouse" Soil.

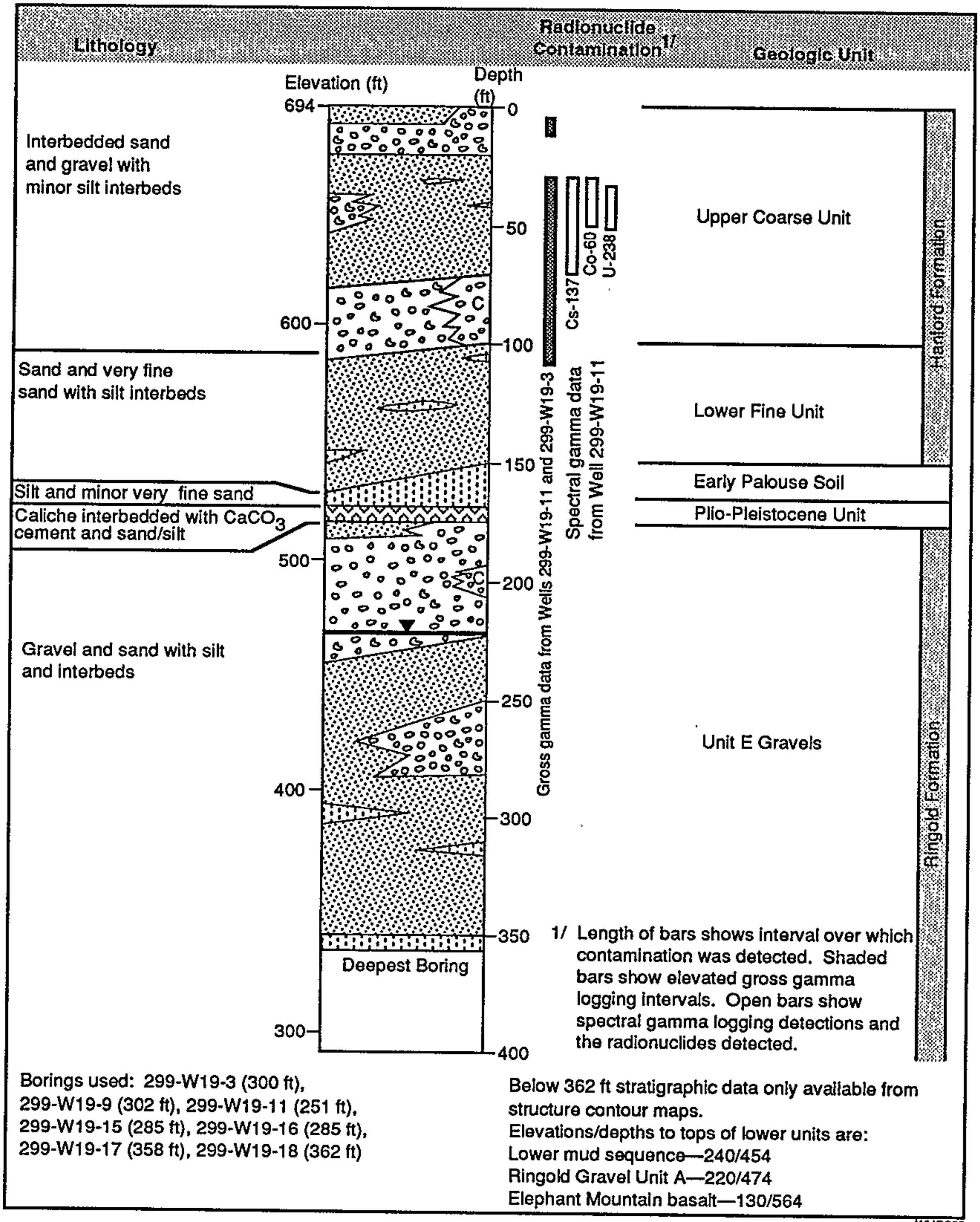


Figure 2-6. Composite Stratigraphic Column for the 216-U-1 and 216-U-2 Cribs and the 2607-W-5 Septic Tank.

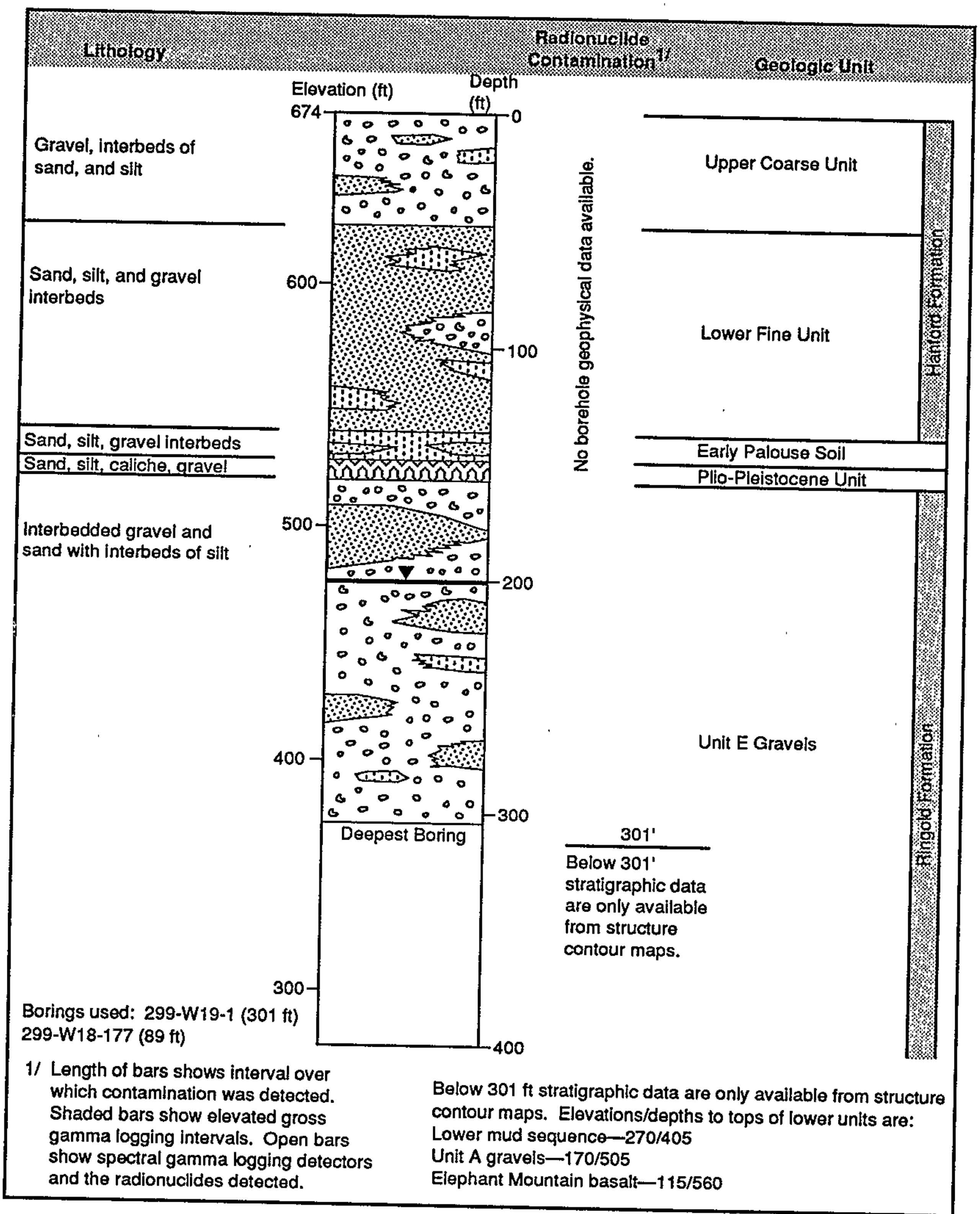


Figure 2-7. Composite Stratigraphic Column for the 216-U-3 French Drain.

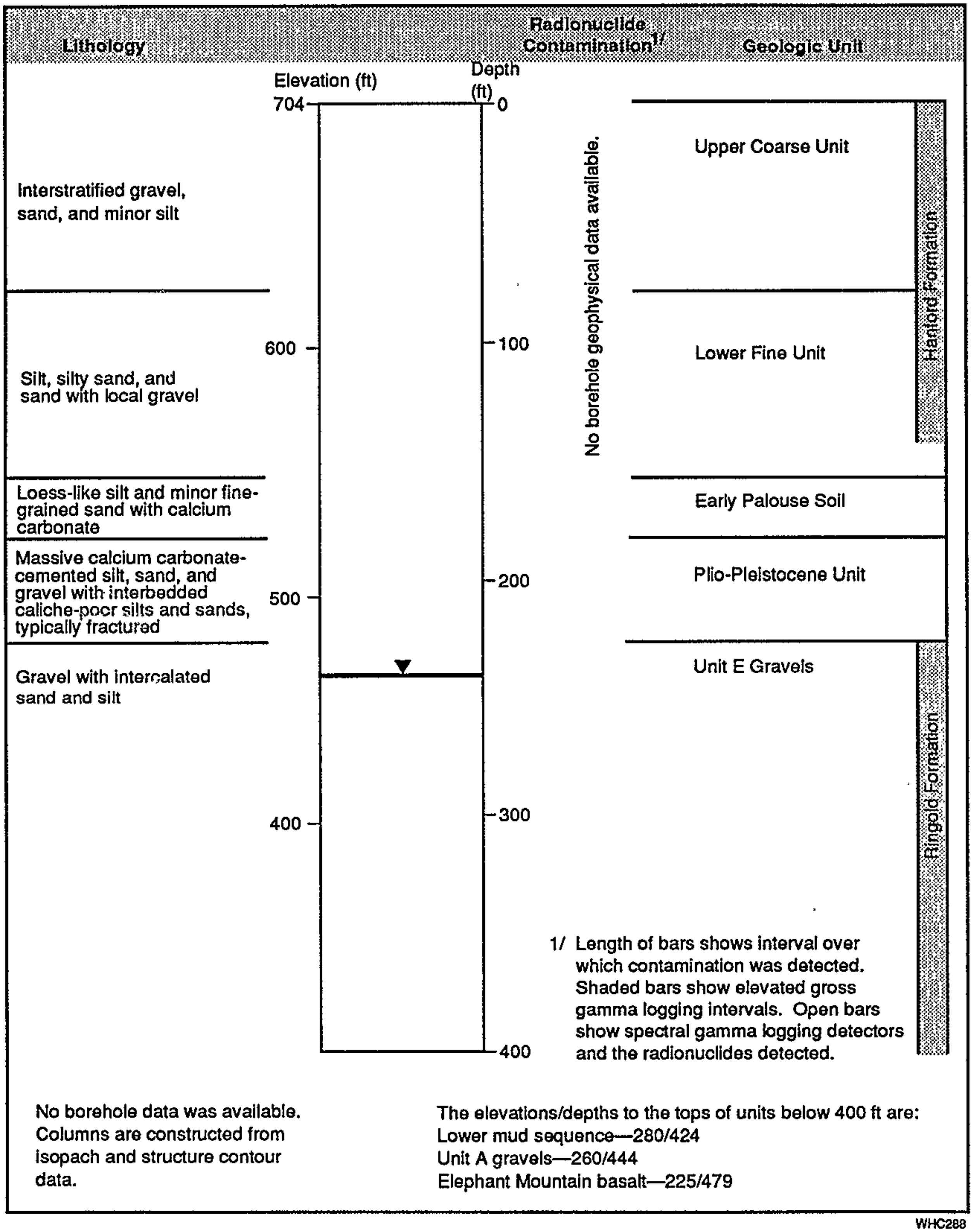


Figure 2-8. Stratigraphic Column for 216-U-4, 4A, 4B Reverse Well and French Drains.

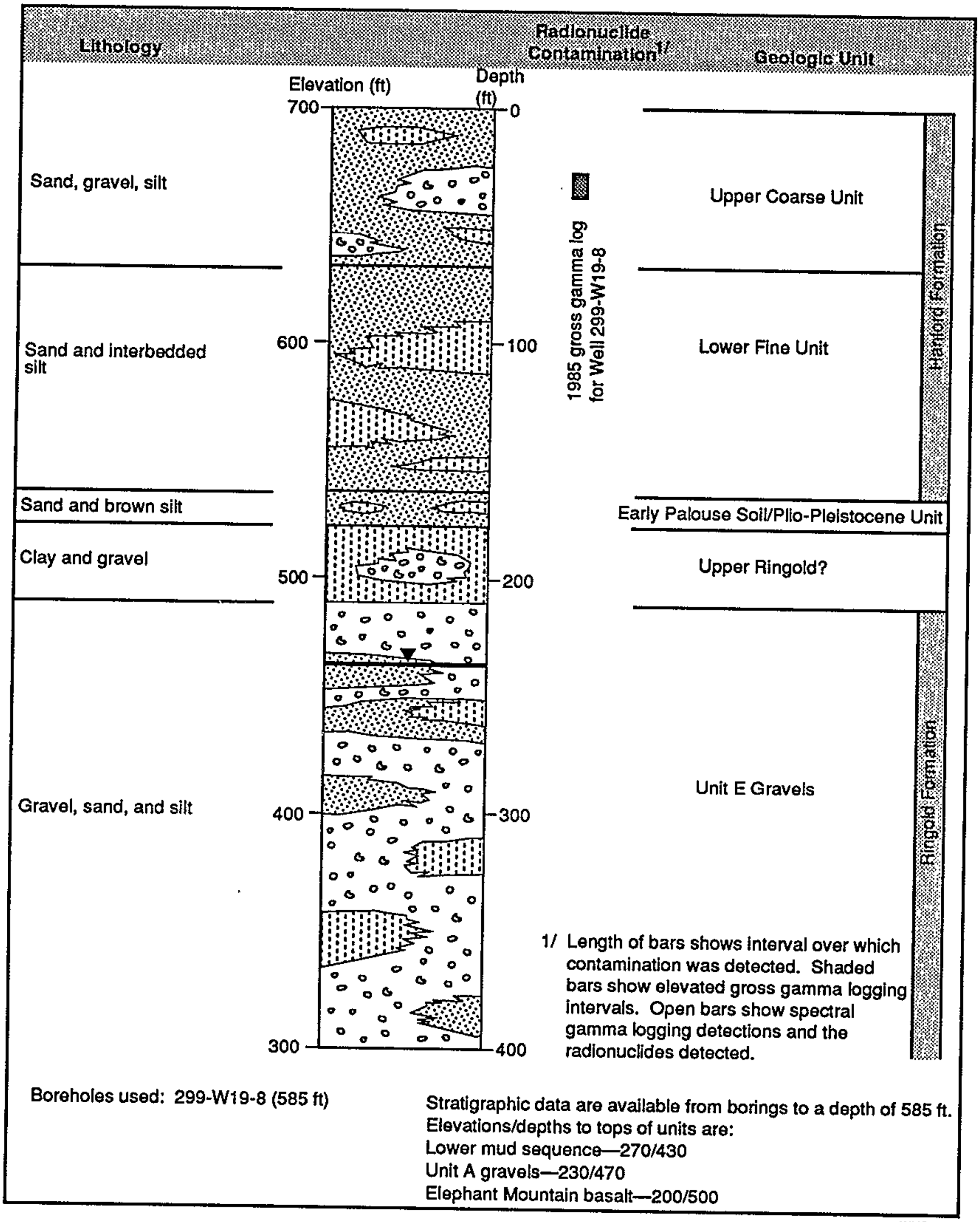


Figure 2-9. Composite Stratigraphic Column for the 216-U-7 French Drain.

9 3 1 2 5 0 1 7 1 0

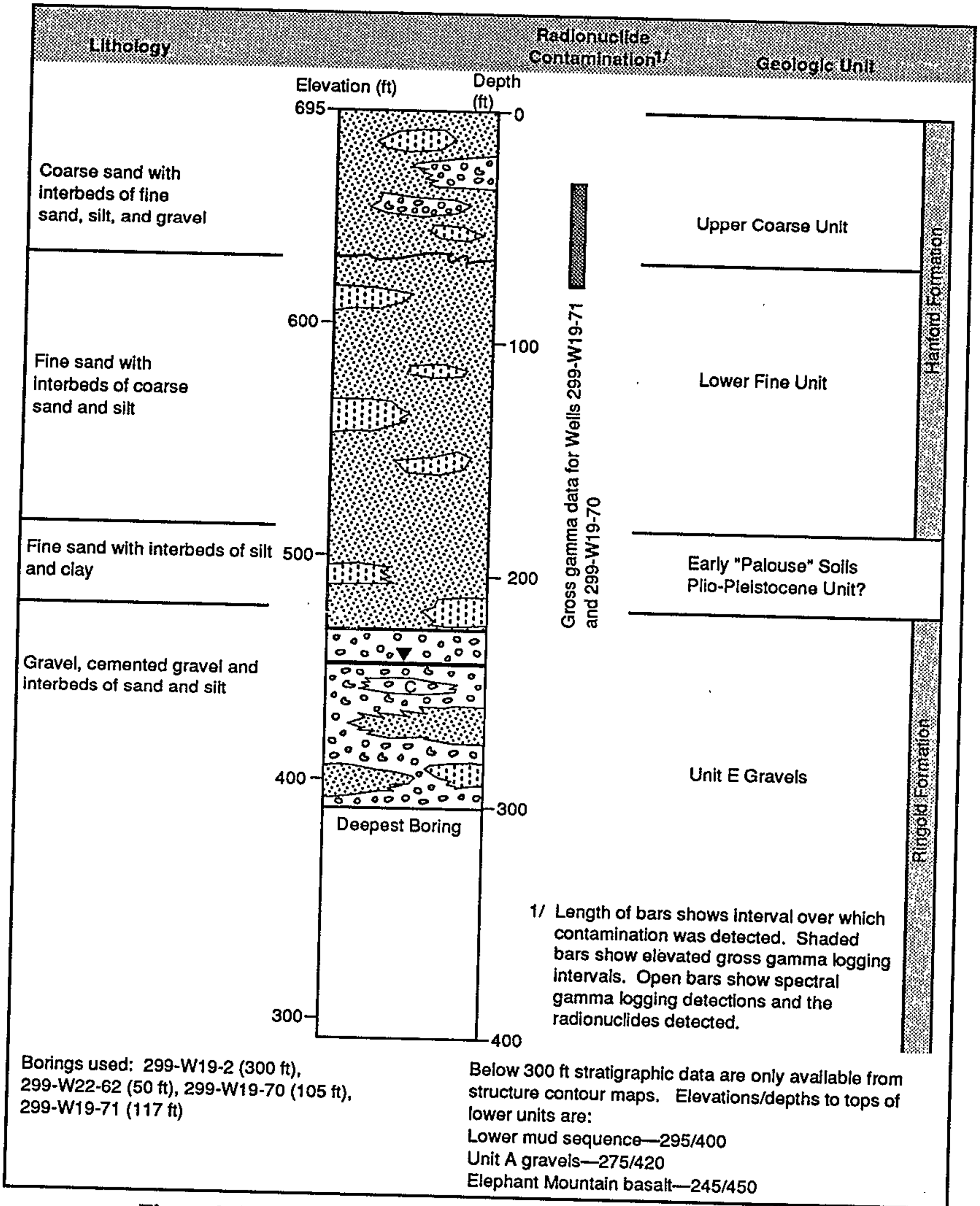


Figure 2-10. Composite Stratigraphic Column for the 216-U-8 Crib.

WHC288

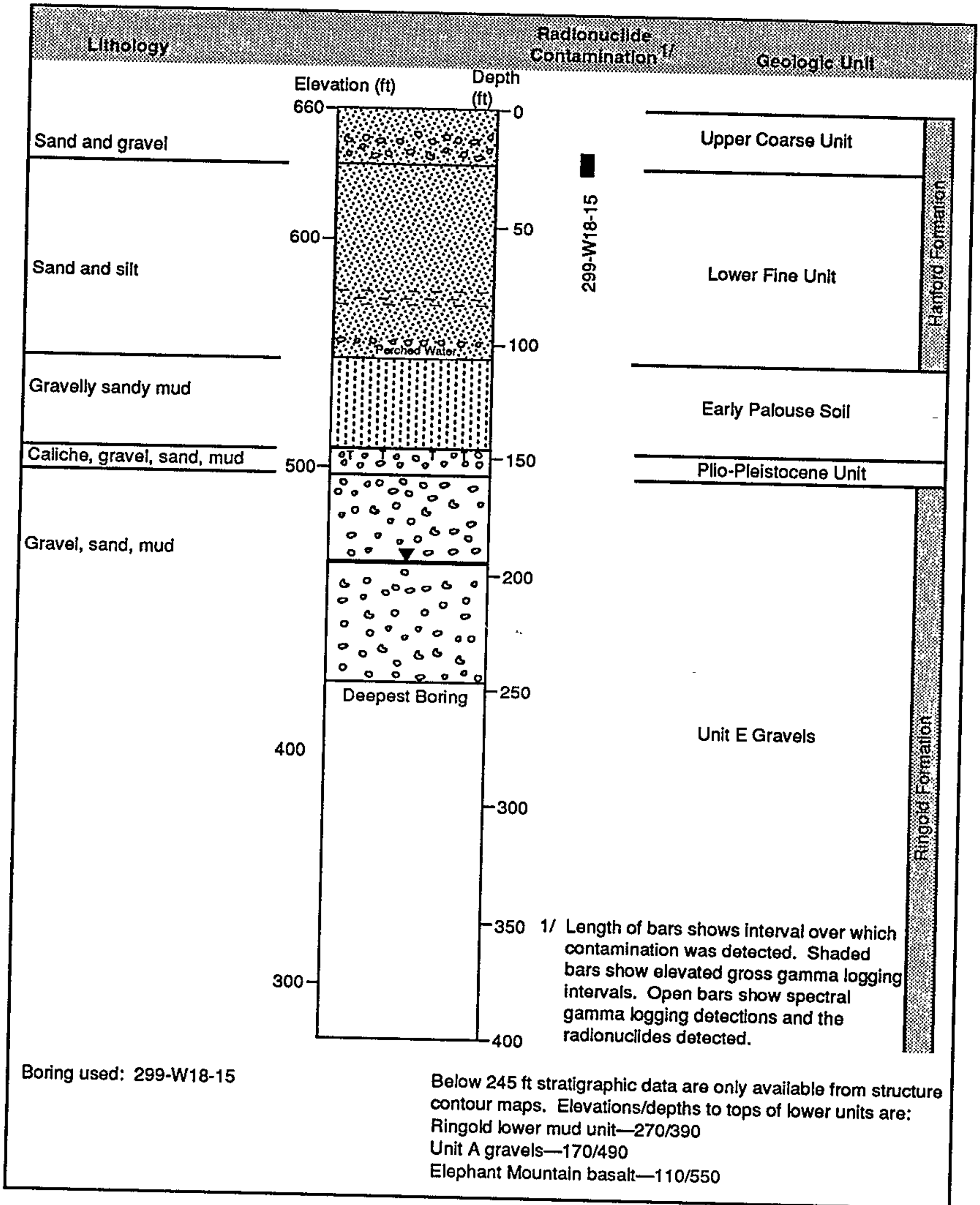


Figure 2-11. Stratigraphic Column for the 216-U-10 Pond.

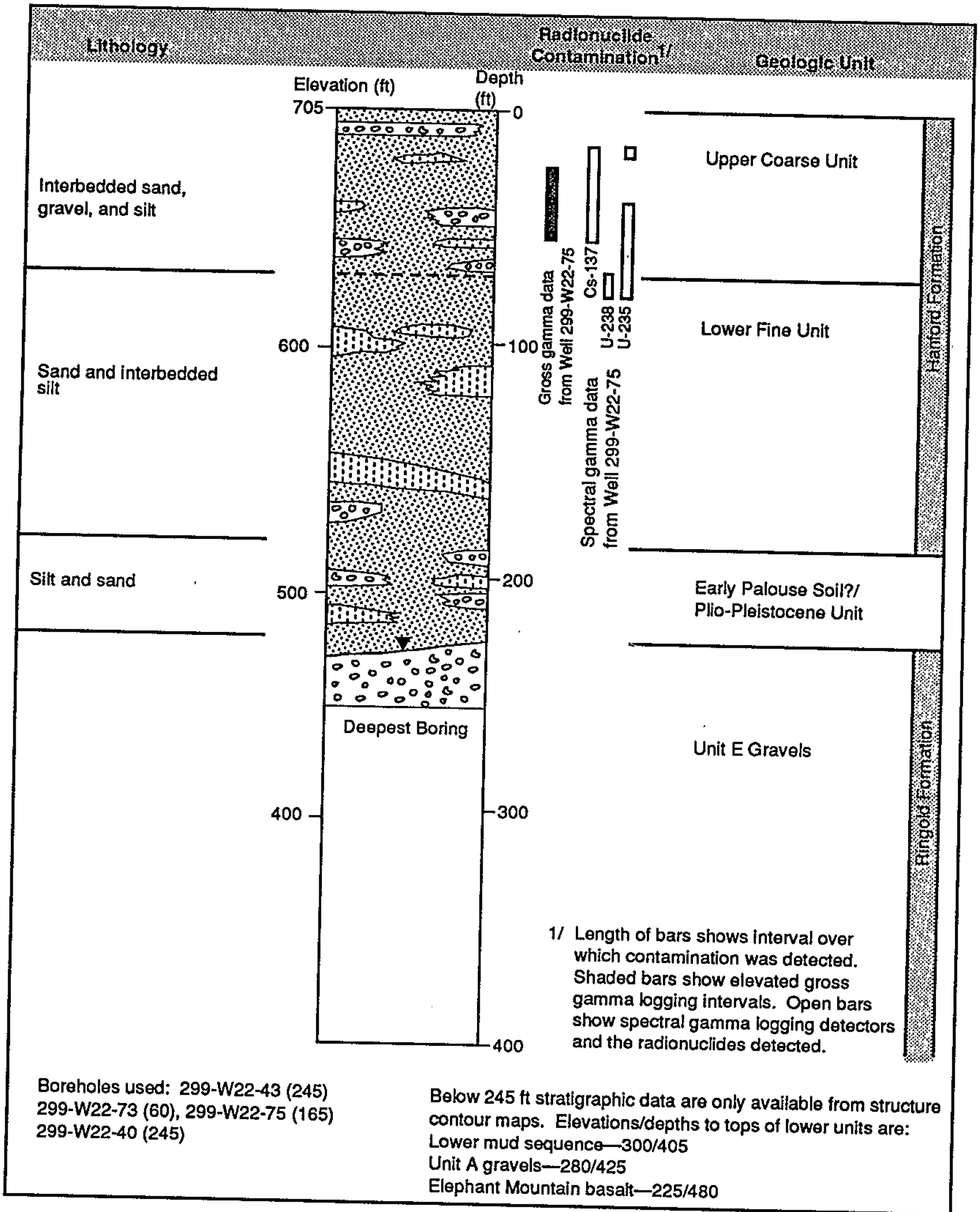


Figure 2-12. Composite Stratigraphic Column for the 216-U-12 Crib.

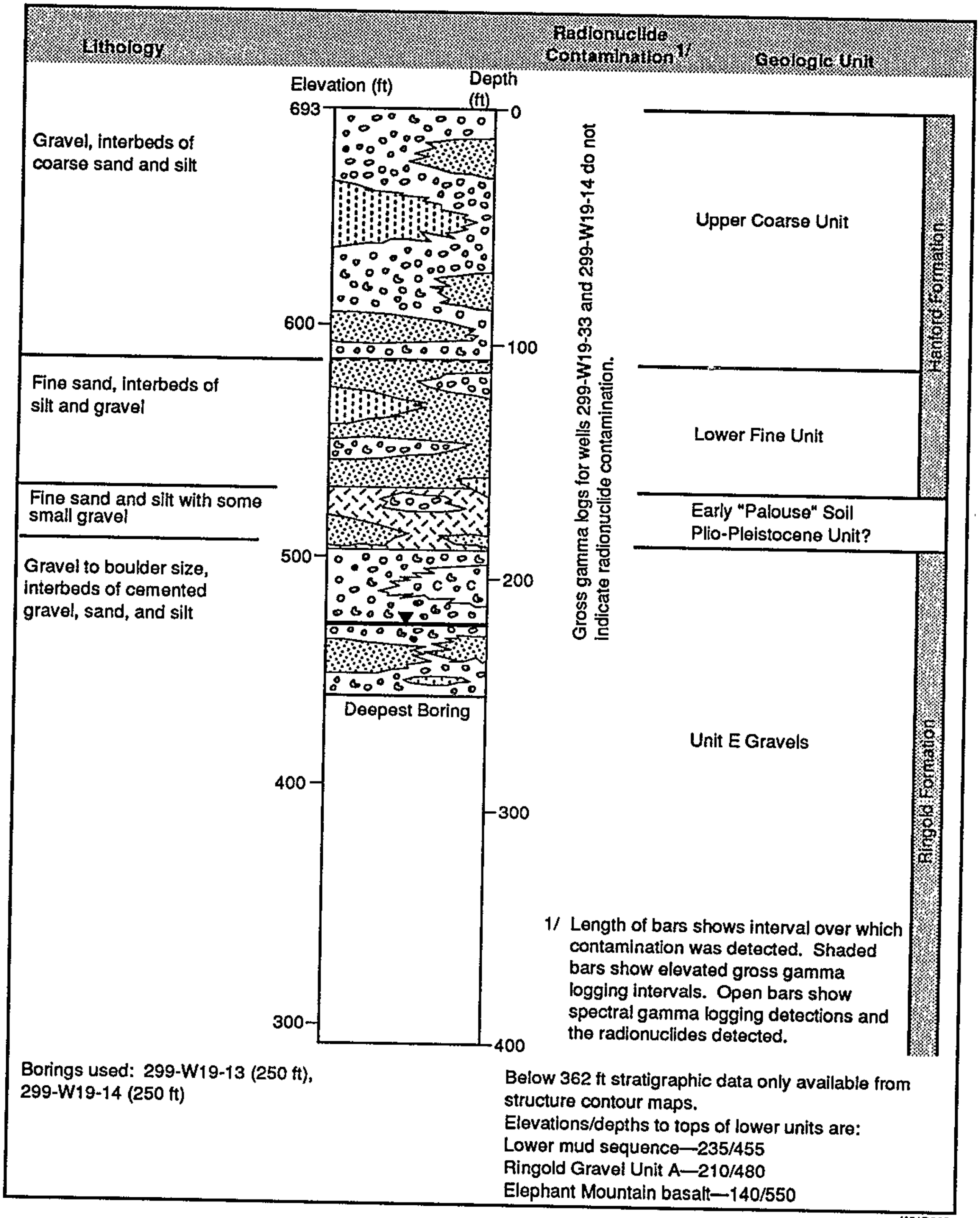


Figure 2-13. Composite Stratigraphic Column for the 216-U-16 Crib.

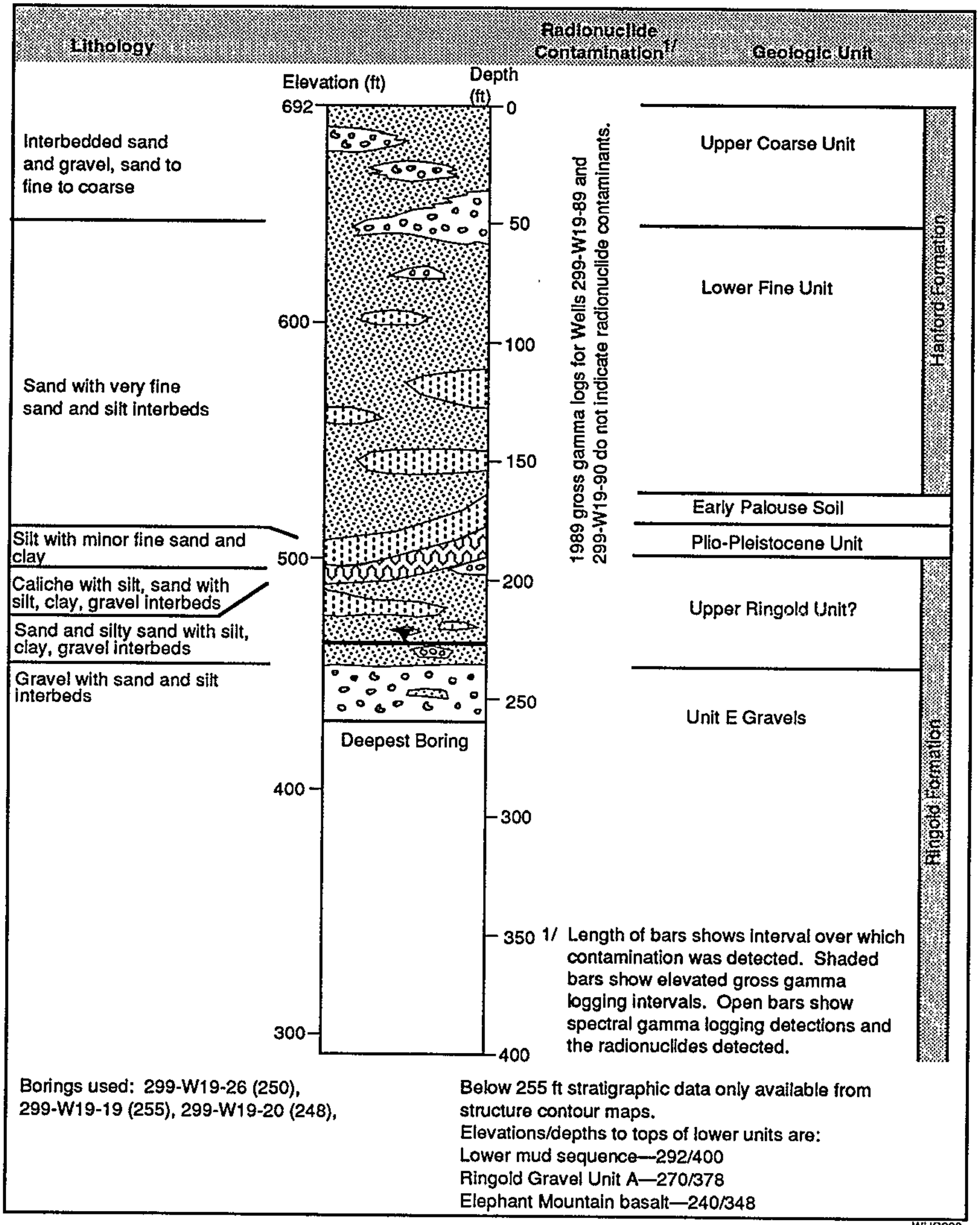


Figure 2-14. Composite Stratigraphic Column for the 216-U-17 Crib.

9 2 1 2 3 1 7 1 5

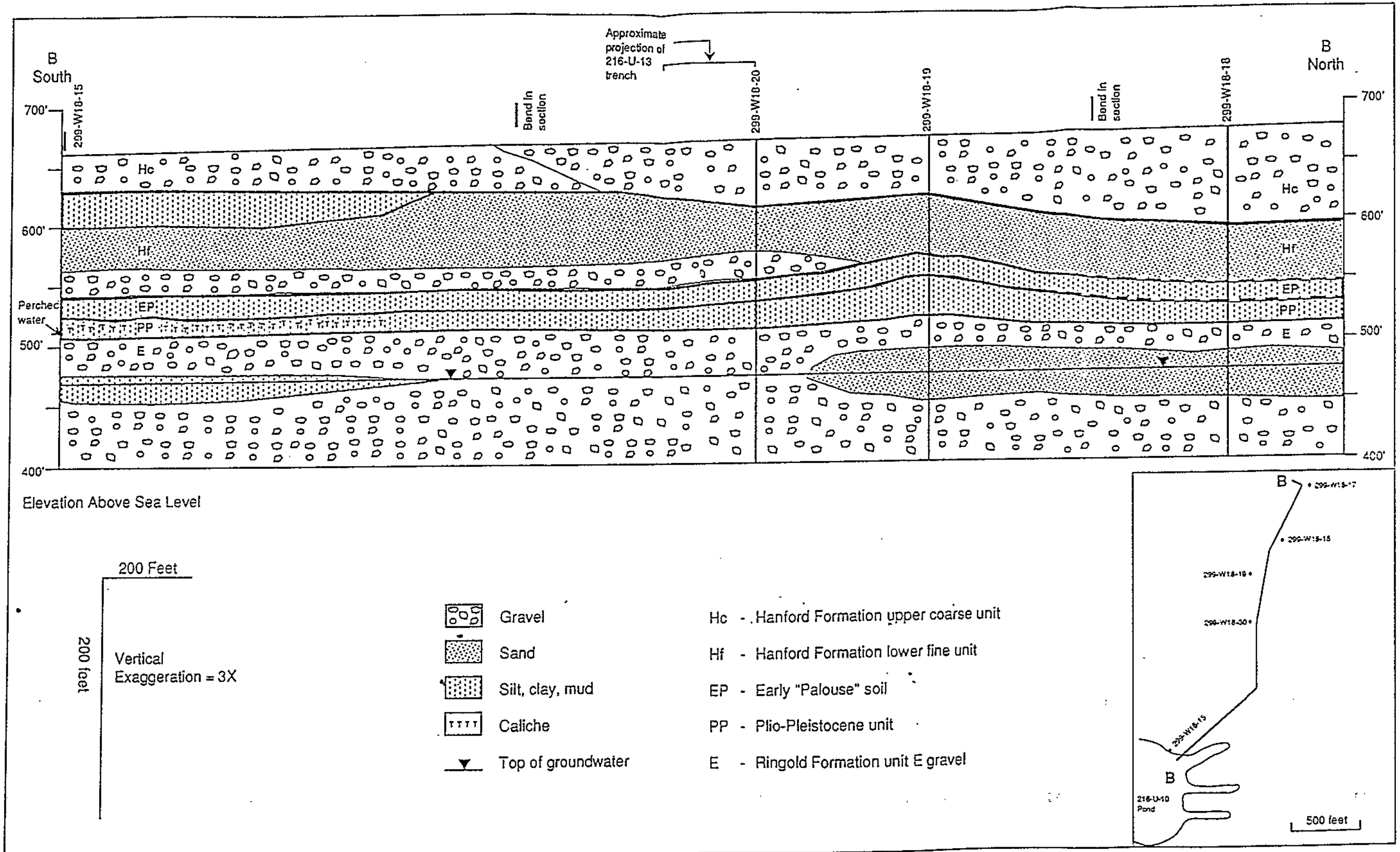


Figure 2-15. Geologic Cross Section Along the Length of the Z Ditches.

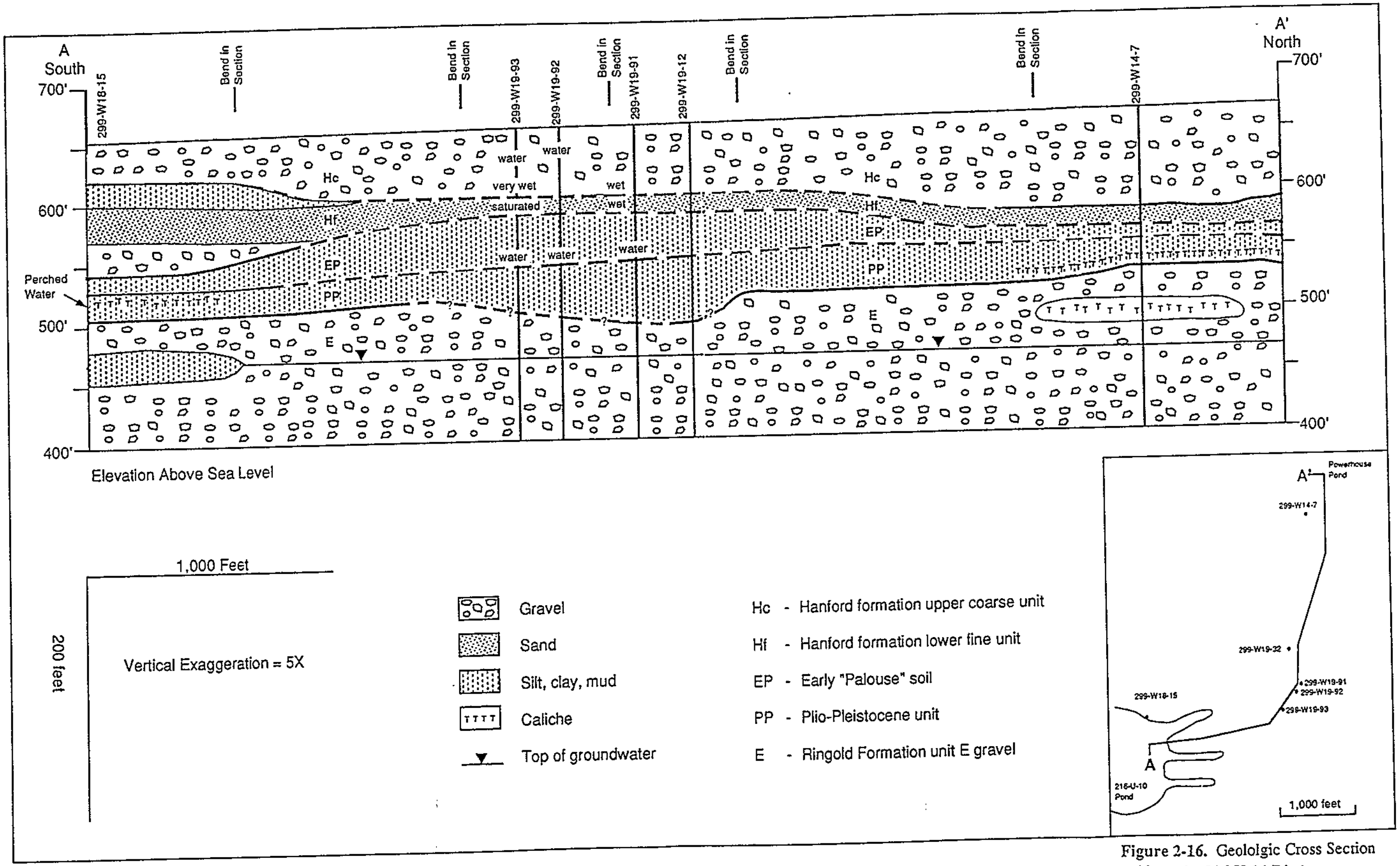


Figure 2-16. Geololgic Cross Section Along the 216-U-14 Ditch.

Table 2-1. Physical Characteristics of the Waste Management Units.

Facility	Depth (m) To:	Plan View Dimensions	Collapse Potential?	Comments
		Cribs and Drains		
216-U-1/216-U-2 Cribs	Top 4.9 m Bottom 6.1 m	3.6 x 3.6 m	Yes	Two open wood cribs, 18 m apart
216-U-8 Crib	Top 6.4 m Bottom 9.4 m	49 x 18 m	Yes	Three open timber cribs (each 4.9 x 4.9 x 3 m) in a N-S oriented trench
216-U-12 Crib	Top 1.8 m Bottom 6 m	30 x 3 m	No	Gravel-filled, drain field-type crib
216-U-16 Crib	Top 3 m Bottom 5 m	19 x 58 m	No	Gravel-filled, drain field-type crib, polyvinyl (PVC) header pipes form N, E, and W borders of field
216-U-17 Crib	Top 5.5 m Bottom 5.5 m	1.5 x 24 m	No	A drain field-type crib
216-U-3 French Drain	Bottom 3.6 m	1.8 m diameter	No	Bottom is 1.8 m diameter with side slopes of 3:1 to the surface
216-U-4A French Drain	Bottom 1.2 m	1.3 m diameter	No	Open pipe
216-U-4B French Drain	Bottom 3 m	.91 m diameter	No	Concrete pipe
216-U-7 French Drain	Bottom 5.2 m	.76 m diameter	No	Gravel filled concrete pipe
		Reverse Wells		
216-U-4 Reverse Well	Bottom 23 m	7.6 cm diameter	No	
		Ponds, Ditches and Trenches		
216-U-10 Pond	Bottom 0.3 - 1.2 m	12 hectares	NA	During deactivation, peripheral areas scraped to a depth of 0.3 m
216-U-14 Ditch	Bottom 1.5 m	2.4 x 1,700 m	NA	Three-fourths of the ditch has been deactivated and filled
216-Z-1D Ditch	Bottom 0.6 m	1.2 x 1,300 m	NA	Partially reexcavated during construction of 216-Z-19 Ditch
216-Z-11 Ditch	Bottom 0.6 m	1.2 x 797 m	NA	Southern 202 m was part of the 216-Z-1D Ditch
216-Z-19 Ditch	Bottom 1.2 m	1.2 x 842.8 m	NA	--
216-U-11 Trench	?	1.5 x 1,048 m	NA	U-shaped trench

3.0 INITIAL EVALUATION

This section briefly describes the known and suspected contamination, the potential impacts to human health and the environment, the preliminary ARARs, and the preliminary remedial action objectives (RAOs), and alternatives for the 200-UP-2 Operable Unit. Section 3.1 summarizes the types of data available for each waste management unit and what they indicate of the distribution and character of the contamination. It is a summary of Section 4.1 in the U Plant Source AAMSR. Section 3.2 discusses the site conceptual model developed in the U Plant Source AAMSR. Physical conceptual models for individual waste management units are provided in Section 4.0 of this work plan. It also discusses concerns about human health and the environment and summarizes the U Plant Source AAMSR Sections 4.2 and 5.0. Section 3.3 is a summary of Section 6.0 (ARARs) of the U Plant Source AAMSR. Section 3.4 discusses the possible IRMs and summarizes Section 7.0 in the U Plant Source AAMSR.

3.1 KNOWN AND SUSPECTED CONTAMINATION

This section summarizes the unit-specific data that are available for the waste management units of concern. Table 3-1 shows all the types of data that are available for each waste management unit. A more thorough presentation of the data is available in Section 4.1.2 of the U Plant Source AAMSR. New data available for the cribs and drains, and ponds, ditches, and trenches is presented in the following sections.

3.1.1 Cribs and Drains

The types of information available for most of the cribs include chemical and radiological inventory data, surface radiological survey results, and radiological borehole geophysical data. The 216-U-12 Crib also has external radiation monitoring data available. Radiological inventory data and surface radiological survey results are available for the drains. The 216-U-3 French Drain also has radiological borehole geophysical data available. Soil, vegetation, and air monitoring data are generally unavailable for these waste management units.

Many of the wells surrounding the cribs and drains have undergone gross gamma logging. These results are summarized in Appendix A of the U Plant Source AAMSR. Two of the four wells currently scheduled for spectral gamma logging in the 200-UP-2 Operable Unit were completed in time for inclusion in this work plan: 299-W19-11, associated with the 216-U-1 Crib; and 299-W19-75, associated with the 216-U-12 Crib. A report is currently being prepared which will formally present the Radionuclide Logging System

(RLS) data (WHC 1992). Four radionuclides were identified by the first two RLS surveys: ^{137}Cs, ^{60}Co, ^{235}U, and ^{238}U.

The depths below the surface at which these radionuclides were detected in Well 299-W-19-11 (216-U-1 Crib) were:

Cesium-137:		
Depths	0.46 to 3 m (1.5 to 10 ft)	<10 pCi/g
Depths	9.4 to 10.4 m (31 to 34 ft)	4,000 pCi/g max
Depths	10.4 to 25 m (34 to 82 ft)	180 to <10 pCi/g
Cobalt-60:		
Depths	9.4 to 15 m (31 to 49 ft)	<10 pCi/g
Uranium-238:		
Depths	10 to 16 m (33 to 52 ft)	900 pCi/g max

The depths below the surface at which these radionuclides were detected in 299-W22-75 (216-U-12) were:

Cesium-137:		
Depths	4.8 to 18 m (16 to 59 ft)	10 to 50,000 pCi/g
Uranium-235:		
Depths	22 to 24 m (72 to 79 ft)	Concentration not estimated
Uranium-238:		
Depths	5.2 to 6.1 m (17 to 20 ft)	300 pCi/g max
Depths	13 to 24 m (43 to 79 ft)	< 100 to 400 pCi/g

Appendix A of the work plan presents more detailed information on the logging technique and the results.

3.1.2 Ponds, Ditches, and Trenches

Inventory and surface radiation survey data are available for the most of the ponds, ditches, and trenches in the 200-UP-2 Operable Unit. In addition, the 216-U-10 Pond and its associated ditches were all extensively sampled before their closure (Last and Duncan, 1980). Generally, only shallow (<3 ft, 1 m deep) soil samples were collected, during these past studies, but a limited number of deeper borings were also made. The highest concentrations for most radionuclides occurred in the 216-U-10 Pond delta area. The delta was located in the northeast corner of the pond, and was where the Z Ditches and the 216-U-14 Ditch fed into the pond. The highest concentrations noted for any of these previous samples were:

Uranium	1,238 ppm
$^{239,240}Pu$	12,500,000 pCi/g (total)
^{241}Am	28,000 pCi/g
^{90}Sr	724 pCi/g
^{137}Cs	19,600 pCi/g

The concentration noted by Last and Duncan in the 216-U-14 ditch were generally much lower than those in the 216-U-10 Pond. A recent sampling effort (1991) encountered the following maximum concentrations:

Uranium	69 ppm
$^{238,240}Pu$	1.18 pCi/g (total)
^{90}Sr	9.4 pCi/g
^{137}Cs	950 pCi/g
K	26.3 pCi/g

3.2 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This section summarizes the qualitative evaluation of human health and environmental hazards made in Section 4.2 of the U Plant Source AAMSR. The AAMSR assessment includes a discussion of release mechanisms and potential transport pathways, develops a conceptual model of human exposure based on these pathways, and presents the physical, radiological, and toxicological characteristics of the known or suspected contaminants. The AAMSR assessment of environmental risks was severely constrained by the relative lack of data regarding potentially exposed biotic populations and exposure pathways.

3.2.1 Conceptual Model

Contaminants were intentionally and unintentionally released to the environment in the operable unit. The release mechanisms and transport pathways are discussed in Sections 4.2.1 and 4.2.2 of the U Plant Source AAMSR.

Figure 3-1 presents a graphical summary of the physical characteristics and mechanisms at the Hanford Site which could potentially affect the generation, transport, and impact of contamination in the 200-UP-2 Operable Unit on humans and biota (conceptual model).

There are four exposure routes by which humans (offsite and onsite) and other biota (plants and animals) can be exposed to contaminants released in the operable unit. These are listed in order of importance:

- Inhalation of airborne volatiles or fugitive dust with adsorbed contamination
- Ingestion of surface water, fugitive dust, surface soils, biota (either directly or through the food chain), or groundwater
- Direct contact with the waste materials (such as those exhumed by burrowing animals), contaminated surface soils, buildings, or plants, and
- Direct radiation from waste materials, surface soils, building surfaces, or fugitive dust.

The conceptual model is discussed in more detail in Sections 4.2.3 and 5.2 of the U Plant Source AAMSR.

3.2.2 Characteristics of Contaminants

Contaminants of potential concern for the 200-UP-2 Operable Unit were identified in the U Plant Source AAMSR. The chemicals listed in Table 4-24 of the AAMSR were selected based upon known presence in waste, disposal in waste management units, historical association, or detection in environmental media at the 200-UP-2 Operable Unit. This list was shortened by removing short-lived radionuclides, chemicals with no known carcinogenic or toxic effects, and progeny radionuclides that will not build to more than 1% of the parent activity within 50 years. Table 4-26 in the U Plant Source AAMSR contains this shortened list. Table 3-2 is the final list of contaminants of concern for the 200-UP-2 Operable Unit. Radionuclides were excluded from the final list if they were expected to occur in negligible amounts compared to the dominant radionuclides. The target analyte list presented in Section 5.0 was derived from the contaminants of concern listed in Table 3-2.

3.3 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended the CERCLA by requiring that all ARARs be employed during implementation of a hazardous waste management cleanup.

The ARARs focus on federal or state statutes, regulations, criteria and guidelines. Also included in the evaluation were DOE Orders that carry out authority granted to the DOE by the Atomic Energy Act (AEA). The DOE orders are considered potential TBCs. The TBC requirements are other federal and state criteria, advisories, and regulatory guidance that are not promulgated regulations, but are to be considered in evaluating alternatives. The U Plant AMMS evaluates contaminant-, location-, and action-specific ARARs.

Contaminant-specific ARARs are usually health- or risk-based numerical values or methodologies that, when applied to unit-specific conditions, result in the establishment of numerical contaminant values that are generally recognized by the regulatory agencies as allowable to protect human health and the environment. In the case of the 200-UP-2 Operable Unit, contaminant-specific ARARs address chemical constituents and/or radionuclides. The potential contaminant-specific ARARs that were evaluated for the 200-UP-2 Operable Unit are discussed in Section 6.2 of the U Plant Source AAMSR.

The potential location-specific ARARs that were evaluated for the 200-UP-2 Operable Unit are discussed in Section 6.3 of the U Plant Source AAMSR. The potential action-specific ARARs that were evaluated are discussed in Section 6.4 of the U Plant Source AAMSR.

3.4 PRELIMINARY REMEDIAL ACTION OBJECTIVES AND ALTERNATIVES

The preliminary remedial action technologies are described in Section 7.0 of the U Plant Source AAMSR. In the AAMSR preliminary RAOs, general response actions, remedial technologies and potential remedial action alternatives were identified based on contaminants of concern, potential routes of exposure, and potential ARARs. The overall objective of Section 7.0 was to identify viable and innovative remedial action alternatives for each media of concern. Section 6.0 of this work plan also discusses remedial alternatives development, screening, and analysis. These remedial action alternatives are general and cover a broad range of actions. The preliminary remedial action alternatives will be used to focus the range of alternatives evaluated in unit-specific focused feasibility studies. The preliminary alternatives were also developed to help identify additional unit-specific information that would be needed to complete an alternative development and evaluation. This additional information will be gathered through site LFIs, RIs, or treatability studies.

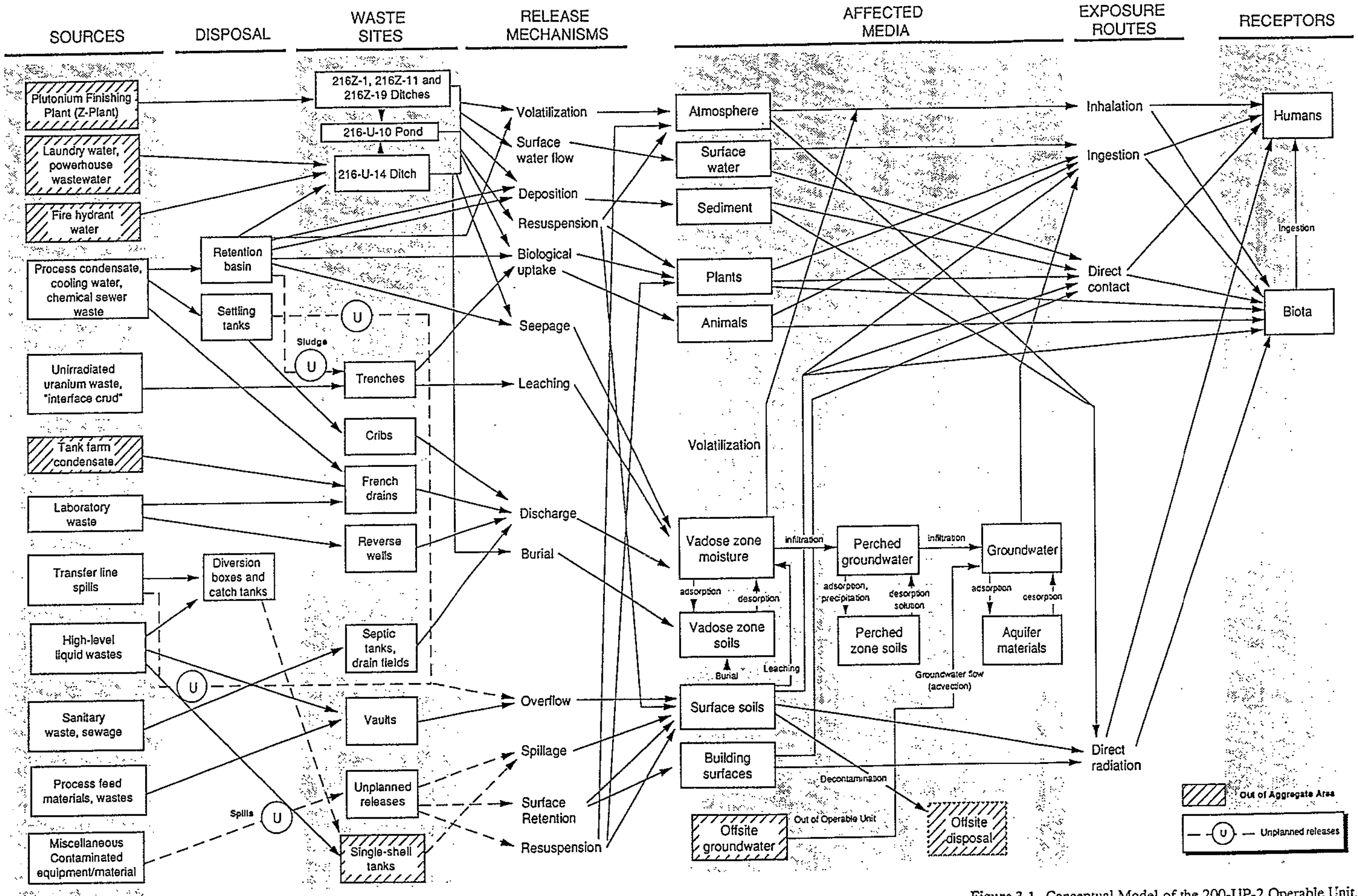


Figure 3-1. Conceptual Model of the 200-UP-2 Operable Unit.

Table 3-1. Types of Data Available for Each Waste Management Unit. Page 1 of 2

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil, or Sediment Sampling	Biota Sampling	Borehole Geophysics
Tanks and Vaults						
241-U-361 Settling Tank	--	--	--	--	--	--
Cribs and Drains						
216-U-1/216-U-2 Cribs	R,C	R	--	--	--	R
216-U-8 Crib	R,C	R	--	--	--	R
216-U-12 Crib	R	R	R	--	--	R
216-U-16 Crib	R	R	--	--	--	R
216-U-17 Crib	R	R	--	--	--	R
216-U-3 French Drain	R	R	--	--	--	R
216-U-4A French Drain	R	R	--	--	--	--
216-U-4B French Drain	R	R	--	--	--	--
216-U-7 French Drain	R	R	--	--	--	--
Reverse Wells						
216-U-4 Reverse Well	C	R	--	--	--	--

Table 3-1. Types of Data Available for Each Waste Management Unit. Page 2 of 2

Waste Management Unit	Inventory	Surface Radiological Survey	External Radiation Monitoring	Waste, Soil, or Sediment Sampling	Biota Sampling	Borehole Geophysics
Ponds, Ditches, and Trenches						
216-U-10 Pond	R	R	R	R	--	--
216-U-14 Ditch	--	R	R	R	--	R
216-Z-1D Ditch	R	--	--	R	--	--
216-Z-11 Ditch	R	--	--	R	--	--
216-Z-19 Ditch	R	R	--	R	--	--
216-U-11 Trench	--	R	--	R	--	--
Basins						
207-U Retention Basin	--	R	--	R	R	--

Notes:
C = Chemical-related data
R = Radionuclide-related data

Table 3-2. Contaminants of Potential Concern for the 200-UP-2 Operable Unit

RADIONUCLIDES

Gross alpha
Gross beta

TRANSURANICS

Americium-241
Americium-242
Americium-242m
Americium-243
Curium-244
Curium-245
Neptunium-237
Neptunium-239
Plutonium-238
Plutonium-239/240
Plutonium-241

URANIUM

Uranium-233
Uranium-234
Uranium-238

FISSION PRODUCTS

Antimony-126m
Barium-137m
Bismuth-210
Bismuth-211
Bismuth-213
Bismuth-214
Carbon-14
Cesium-134
Cesium-135
Cesium-137
Cobalt-60
Europium-152
Europium-154
Europium-155
Francium-221
Iodine-129

FISSION PRODUCTS (continued)

Lead-209
Lead-211
Lead-212
Lead-214
Nickel-59
Niobium-93m
Polonium-214
Polonium-218
Potassium-40
Protactinium-231
Protactinium-234m
Ruthenium-106
Samarium-151
Selenium-79
Sodium-22
Strontium-90
Technetium-99
Thallium-207
Thorium-229
Thorium-230
Thorium-231
Tritium
Yttrium-90
Zirconium-93

HEAVY METALS

Arsenic
Barium
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Titanium

HEAVY METALS (continued)

Vanadium
Zinc

OTHER INORGANICS

Boron
Cyanide
Fluoride
Nitrate

VOLATILE ORGANICS

Acetone
Carbon tetrachloride
Chloroform
Methylene chloride
MIBK ("hexone")
Toluene
1,1,1-Trichloroethane

SEMIVOLATILE ORGANICS

Kerosene
Tributyl phosphate

4.0 WORK PLAN RATIONALE

This section develops the rationale used to design the field program for the 200-UP-2 Operable Unit LFI described in Section 1.0. Data Quality Objectives (DQOS) were developed in the U Plant Source AAMSR according to EPA guidance (EPA 1987). Section 4.1 of this Work Plan describes the data uses and data needs identified in Section 8.0 of the U Plant Source AAMSR and summarizes the data requirements at specific waste management units. Section 4.2 discusses the rationale for selecting specific field activities at individual waste management units.

4.1 DATA USES AND DATA NEEDS

This section describes the data uses and needs identified in the U Plant Source AAMSR. Section 8.0 of the AAMSR identified the potential data users and the data they require. With this background, the data needs for the area were established and general investigation methodologies were determined.

The primary data uses identified in the U Plant Source AAMSR include the following:

- Site characterization for ARARs evaluation
- Public health evaluation and qualitative human health and ecological risk assessments
- Evaluation of remedial action alternatives
- Worker health and safety.

Contaminant-specific ARAR assessment will require data on the nature and extent of contamination in various environmental media.

Public health evaluation and risk assessment for the 200-UP-2 Operable Unit LFI involves the performance of a qualitative risk assessment. This assessment provides a semi-quantitative assessment of risk and focuses on the principal risk drivers in the operable unit. The data for this assessment is collected during the LFI and confirmatory sampling, and is compiled from existing information. The results of this assessment are used to help determine the need for an IRM, to select the IRM, and to determine risk-based cleanup levels for the IRM. The qualitative risk assessment will be conducted using the *Hanford Site Baseline Risk Assessment Methodology* (DOE/RL 1992b) and any guidance specific to qualitative risk assessments as it becomes available. Data collected during LFI and confirmatory sampling may ultimately be used for the quantitative baseline risk assessment as well, according to guidance by the Hanford Site Baseline Risk Assessment Methodology (DOE/RL 1992b).

The evaluation of remedial action alternatives at the operable unit also includes two distinct activities, one associated with the LFI/IRM path and the other associated with the final feasibility study. This work plan focuses on collecting the data required for selecting appropriate IRMs at the cribs, french drains, and the 216-U-10 Pond System. Data needed for developing and evaluating IRMs includes:

- Nature and extent of contamination
- Information on the location, design, uses, and decommissioning of the waste disposal units
- Nature and extent of contamination of surface water, sediment, and biota
- Treatability study information relevant to the limited range of interim actions that may be considered.

The worker health and safety category includes data collected to determine the required level of protection for workers during various investigation activities.

Each of these data uses has specific data needs that were developed in Section 8.2.2 of the U Plant Source AAMSR. During the AAMSR process, the available data were compiled and reviewed to determine usefulness and to identify data gaps. These data are presented in Sections 2.0, 3.0, and 4.0 of the U Plant Source AAMSR. The data needs and data quality objectives of the LFI are largely driven by the needs of the qualitative risk assessment and for selecting appropriate IRMs. The types of information required for these tasks include 1) maximum concentrations at depth, 2) maximum vertical contaminant distribution, 3) lateral extent and maximum contaminant concentrations at the surface, and 4) perched water extent and contaminant concentrations.

EPA (1987) has specified five indicators of data quality (precision, accuracy, representativeness, completeness and comparability) which can be used to specify requirements for data collection. These parameters are discussed in detail in Section 8.1 of the U Plant Source AAMSR and are summarized below in the context of the present study.

The objectives for accuracy and precision for this project are detailed in Table QAPjP-1 of the attached QAPjP.

In order to meet the representativeness DQO requirement, samples shall be collected in a manner that assures they are representative of the highest concentrations at each waste management unit. Borings must be placed so that they will encounter the most contaminated horizons beneath a unit, and sampling intervals must be determined so that the material most likely contaminated is collected. Borings must also be placed so that they will pass through areas that have undergone the largest liquid flux and thus have the greatest potential for the downward migration of radionuclides and for perched water formation. Surface soil samples must be collected from areas where the highest contaminant concentrations are indicated by field screening.

Completeness parameters will be met by using sample protocols that guarantee sufficient sample volumes are collected to assure a high percentage of successful analyses. For borings this may require that alternate or additional sampling intervals be used if insufficient sample is collected from a designated interval.

Comparability will, in part, be tested by resampling areas that were sampled in previous studies. In particular the results of the confirmatory sampling at the 216-U-10 Pond will be compared to the analytical data generated by earlier studies of the same area.

4.2 DATA COLLECTION PROGRAM

This section describes the rationale used in selecting the types, locations, and frequencies of data collection activities. The field program at the 200-UP-2 Source Operable Unit is designed to efficiently address the data needs and recommendations developed in the U Plant Source AAMSR and summarized in Section 4.1 of this work plan.

Section 8.3 of the U Plant Source AAMSR presented a general data collection program for the 200-UP-2 Operable Unit. The general methodologies described in the AAMSR included source investigation, geologic investigation, surface water sediment investigation, soil investigation, air investigation, ecological investigation, geophysical stratigraphic surveying, process effluent pipeline integrity assessment, and geodetic surveying. This section builds on this initial work by providing the rationale for investigation activities at specific waste management units.

Section 4.2.1 summarizes the relationship between field activities and provides the general rationale used to select field activities for each type of waste management unit. Sections 4.2.2 through 4.2.7 detail the selection process for each waste management unit.

4.2.1 General Rationale

Figure 4-1 summarizes the relationship between data uses, data needs, and field activities. As stated in Section 4.1, the primary data uses are (1) potential ARAR assessment, (2) qualitative risk assessment, (3) remedial action alternative assessment, and (4) health and safety concerns. The data collected for risk assessment will be used to address two primary concerns: (1) surface and near surface exposure risk, and (2) the risk of subsurface contaminant migration to the groundwater. The data collected for surface and near surface exposure risk will be used for human health risk assessment and to a much lesser extent for ecological risk assessment. The data acquisition for input into environment risk assessments is managed on a larger scale than individual operable units in order to reflect a more realistic and unified risk scenario. Data collected in this investigation will be used for in the environmental risk assessment, but the ecological investigation is outside the scope of this document. The data collected about the risk of subsurface contaminant migration to the groundwater are largely driven by the input required for modeling flow and transport in the vadose zone. The data needs of the model are presented in the *Groundwater Model Development Plan in Support of Risk Assessment* (DOE/RL 1991). Climatic and vegetation data for the model are currently available, so most of the additional data needs are specific to the vadose zone.

The field program at each waste management unit was developed by integrating the data needs and associated field activities shown on Figure 4-1 with physical models of contaminant distribution and concentrations.

4.2.1.1 Field Activities and Analyses. This section summarizes the rational behind general field activities and analyses.

4.2.1.1.1 Field Activities. Each data use has certain requirements best fulfilled by specific field activities. For example, the vertical extent of contamination in the vadose zone is best assessed by borings with subsurface sampling and by subsurface geophysics. As shown on Figure 4-1, one type of field activity will frequently address more than one data need. For example, the data needs addressed by the seismic reflection survey include stratigraphic characteristics and vadose zone moisture transport (identification of perched water zones).

In addition to their connection with data uses and needs, some field activities provide data that are required to efficiently perform subsequent activities. These interrelated activities are connected by arrows on the right side of Figure 4-1. For example, surface radiation survey data will be used to locate contaminated areas for surface soil sampling, surface water sediment sampling, and soil borings. The data needs fulfilled by specific field activities are outlined below:

- Air monitoring data will determine the effects of other field activities on air quality. These data will assess the potential health effects to onsite workers during field activities.

- Surface radiation surveys are required to determine potential worker exposures during other field activities and to assess potential long-term exposure risk. The data will also be used as a screening tool to locate the most heavily contaminated areas for surface soil sampling and borings. For these reasons it will be necessary to conduct surveys over areas that have been surveyed in the past.

- Surface geophysics data derived from ground penetrating radar and electromagnetic surveys will locate buried objects and determine the location and extent of filled excavations. These data will then be used to optimize test pit placement.

- Surface soil and surface water sediment sampling data will assess the types and concentrations of surface contaminants at each waste management unit.

- Borings, test pit excavation, and subsurface sampling data will determine the vertical and lateral extent of subsurface contaminants. Borings will also provide information on stratigraphy and the extent of perched water zones. Test pit excavation is an economical way to collect samples from the shallow vadose zone (less than 10 m, 33 ft). Sampling data will yield information on the concentration and character of subsurface contaminants and will be used compare subsurface geophysical results with real concentration data. Other samples will be used to characterize subsurface soil mineralogy, chemistry, hydrologic characteristics, and water content. Most borings will extend at least to the Plio-Pleistocene caliche layer so that perched water wells can be installed if appropriate.

- Subsurface geophysics surveys, especially those to obtain spectral gamma data, will support the subsurface soil sampling program. Existing and new wells proposed in this work plan will be surveyed to provide more data for estimating lateral and vertical contaminant extent and to determine the types of subsurface contaminants present.

- Perched water sampling is required to determine the types, concentrations, and extent of contaminants in the perched water. The presence of contaminated perched water should be identified because this may indicate that active contaminant movement is taking place beneath a facility.

- Vadose zone model calibration is required to field check models describing contaminant migration through the vadose zone. This activity requires that soil chemistry, soil hydrology, and moisture characterization data be collected.

- The pipeline integrity assessment includes camera surveys, surface radiological surveys, and test pit excavations. This assessment will indicate if any of the effluent disposal pipelines have leaked.

- The pH boring at the 216-U-12 Crib will be used to characterize the impact of low pH wastes on the underlying soils and to determine the remaining buffering capacity of the soil column beneath the crib.

4.2.1.1.2 Analyses. Soil, water and sediment samples will be collected in conjunction with many of the activities listed above. These samples to will need to undergo analyses to determine the contaminant concentrations they contain or to characterize their physical properties. The list of analyses for these samples is derived from the contaminants of concern list shown on Table 3-2. Six potential analytes have been removed from the contaminants of concern list and one has been added.

The contaminants of concern that will not be analyzed for include:

- Americium-242/-242m - This isomeric isotope is an activation product of Americium-241 and as such will be produced in much lower quantities than Americium-241 in a reactor. Americium-242/-242m would also be very difficult to analyze for because it does not emit a particle or photon that can be readily used for quantification.

- Cesium-135 - This isotope is a decay product of xenon-135. Because xenon is a gas, it will not be retained in any of the media being sampled and so there should be no significant buildup of cesium-135 in the sample.

- Curium-245 - This isotope has a very low production rate in the reactor, as does its parent, Californium-249, so it is not likely to occur in significant quantities in any of the potential samples.

- Nickel-59 - If the nickel in a given sample has all come from the same source, then according to process studies, nickel-59 concentrations will be more than two orders of magnitude less than nickel-63 concentrations. Nickel-59 is also very difficult to analyze for because it does not emit a particle or photon that can be readily used for quantification.

- Niobium-93m - This isotope is very difficult to analyze because it does not emit a particle or photon that can be readily used for quantification.

Beryllium is being added to the list of analytes even though it was not on the original contaminants of concern list from the U Plant Source AAMSR. It is being added because it is a suspected human carcinogen, it is known to be common in Hanford waste streams and it has been detected in environmental samples from other Hanford studies.

Many other contaminants of concern will not be analyzed for directly, because their concentrations can be calculated from isotopes that will be analyzed for. This will save on laboratory costs while yielding reliable calculated concentrations for these radionuclides. Carbon-14, Hydrogen-3 and fluoride will be analyzed for only in water samples because they are unlikely to be retained in dry soil and sediment samples.

The most important use of physical sample data is to provide input for models of contaminant fate and transport in the vadose zone. The data required for these models include: bulk density, particle size distribution, moisture content, calcium carbonate content, saturated and unsaturated hydraulic conductivity, matric potential and soil moisture retention curves, particle density, cation exchange capacity, organic carbon content, pH and Eh, and mineralogy.

4.2.1.2 Physical Model of Contaminant Distribution. Large-scale liquid disposal sites such as cribs, ponds, ditches, and french drains will affect surface and deeper vadose zone soils. Field work at these units will collect data for surface exposure risk assessment, subsurface migration risk assessment, health and safety planning and monitoring, assessing potential ARARs, and assessing potential remedial action alternatives. Contamination at these units is assumed to exist but is of unknown extent, so deep borings or test pits are required.

Several previous studies have been conducted on large-scale liquid release sites. These studies, in conjunction with geophysical well logging data, have been used to estimate expected contaminant distributions beneath comparable sites in the 200-UP-2 Operable Unit. The previous studies include field work at the 216-Z-1A Tile Field, the 216-Z-9 Trench, the 216-Z-12 Crib, the 200-BP-1 Operable Unit cribs (the BY Cribs), the 216-U-10 Pond, and the 216-Z-19 Ditch. All of these studies involved drilling through contaminated sediments under the waste disposal facilities.

These units are comparable to other 200-UP-2 Operable Unit units in several ways:

- Each of these facilities received large volumes of liquid waste containing a similar suite of radionuclides.

- All of these waste management units are hosted by the Upper Coarse unit of the Hanford formation. The 216-U-10 Pond is in the 200-UP-2 Operable Unit, the 216-Z-1A Tile Field and 216-Z-9 Trench are within 300 m (980 ft) of the operable unit boundary. The deep stratigraphy beneath the BY Cribs is very different from the 200-UP-2 Operable Unit, but the first 50 m (164 ft) beneath the operable units are similar. In both locations the first 50 m (164 ft) are made up of gravels, sands, and minor fine-grained interbeds of the Hanford formation.

- Some of these units received acidic waste (216-Z-1A and 216-Z-9) while others received neutral/basic waste (by Cribs, 216-Z-12 and the U Pond system). This is an important distinction because pH strongly affects the migration rate of most radionuclides. In basic solutions, radionuclides such as plutonium sorb rapidly onto sediments and tend to collect immediately below the point of discharge. Acidic solutions will retain radionuclides longer, so contaminants tend to be more deeply distributed beneath the point of discharge (Cleveland 1970).

Data from these previous studies will be summarized in the following sections and then will be used to develop a physical model of contaminant distribution in the subsurface.

4.2.1.2.1 BY Cribs. An important task associated with the BY Cribs is the drilling and sampling of ten inactive cribs within the operable unit. Drilling of the BY Cribs began in spring 1991 with up to three borings planned for each crib. The cribs received neutral/basic waste containing technetium, strontium, cesium, cobalt, uranium, and ruthenium. This suite of contaminants is similar to those disposed of in the 200-UP-2 Operable Unit cribs. The preliminary field results generally indicate that contamination is concentrated directly beneath the crib infiltration gravels and decreases rapidly with depth. Radionuclide concentrations are usually less than detectable at more than 10 m (30 ft) beneath the crib. The highest activity encountered during the initial drilling was 1.9 μCi/g ^{137}Cs and 0.2 μCi/g ^{90}Sr directly under the 216-B-49 Crib (Buckmaster and Kaczor 1992). Preliminary results also suggest that there is very little lateral extent of radionuclides beyond the cribs.

4.2.1.2.2 216-Z-1A and 216-Z-9 Units. The 216-Z-1A Tile Field and the 216-Z-9 Trench both received acidic waste and large inventories of plutonium. In 1972 Smith (1973) investigated the upper 60 cm (20 in.) of sediments underlying the floor of the 216-Z-9 Trench and found that the highest accumulation of plutonium occurred near the center of the trench floor. Sixteen characterization wells were drilled in the vicinity of the 216-Z-1A Tile Field (Price et al. 1979). The bulk of actinide contamination at this unit appears to be contained within the first 15 m (49 ft) of sediments beneath the bottom of the crib. The highest plutonium (40 μCi/g) and americium (2.5 μCi/g) concentrations occurred directly beneath the central distributor pipe of the 216-Z-1A Crib. With the exception of isolated silt lenses, plutonium concentrations in excess of 1 μCi/g were not found more than 2 m (7 ft) beneath the center of the crib. Plutonium concentrations greater than 0.1 μCi/g were not found below 15 m (49 ft). No contamination was detected more than 30 m (98 ft) below the crib. The maximum level of activity encountered in the perimeter wells was generally less than 1 μCi/g. Plutonium and americium contamination in the perimeter wells was only encountered in sediments between 5 m (16 ft) and 30 m (98 ft) below the projected bottom of the crib. No contamination was detected in the seven perimeter wells that were more than 10 m (33 ft) from the crib boundaries (Figure 4-2). The contamination on the margins of the crib is very discontinuous with depth and is generally confined to fine-grained sediments or other interbeds that inhibited the downward flow of water and caused lateral movement.

4.2.1.2.3 216-U-10 Pond and 216-Z-19 Ditch. In 1980 Last and Duncan (1980) conducted an extensive drilling and sampling program at the 216-U-10 Pond and the 216-Z-19 Ditch. Although these units are not cribs or french drains, the study results are considered significant because the units received similar waste and because they are located within the 200-UP-2 Operable Unit. The most significant radionuclides detected in the pond and ditches were ^{137}Cs, ^{90}Sr, ^{241}Am, plutonium, and uranium. Contamination was localized in the upper 10 cm (0.3 ft) of the pond sediments and dropped off rapidly with depth. Contaminant concentrations are highest in the center of the U Pond and in the delta region and decrease towards the old pond margins. Plutonium concentrations below the 216-Z-19 Ditch were highest in the first 30 cm (1 ft.) below the ditch and were two to three orders of magnitude less by 1 m (3 ft) depth. No plutonium was detected deeper than 14 m (46 ft) below the ditch. The americium distribution beneath the ditch was similar to the plutonium distribution. Contaminant concentrations are highest at the bottom of the ditches and decrease towards the sides. The sampling results from these units are presented in Section 4.1.2 of the U Plant Source AAMSR.

4.2.1.2.4 216-Z-12 Crib. The 216-Z-12 Crib received "low-salt" basic waste. Kasper (1981) summarized the study results conducted on this crib. The study results showed that the highest concentration of plutonium (greater than 5,000 pCi/g) occurred in the sediment immediately below the crib bottom. Plutonium concentrations decrease rapidly with distance from the bottom of the crib. Figure 4-3 illustrates the distribution of plutonium activity immediately below the crib. Plutonium activity was less than 10^3 pCi/g, 3 m (10 ft) below the crib and less than 1 pCi/g, 12 m (39 ft) below the crib. An increase in plutonium activity that ranged up to 20 pCi/g occurred from 30 to 36 m (98 to 118 ft) below the crib bottom. The activity was associated with a silt unit at that depth and was probably related to the greater sorption capacity of the silt unit. Plutonium activities of greater than 10^3 pCi/g did not extend laterally beyond the crib fill gravels.

4.2.1.2.5 Gamma Logging. Gross gamma logs are available for wells around most of the cribs and french drains in the 200-UP-2 Operable Unit. As described in Section 3.0, spectral gamma logs are only available at this time for wells at the 216-U-1 and 216-U-12

Cribs. Additional gamma logging is planned at other 200-UP-2 Operable Unit waste management units and data will be reviewed as it becomes available.

Data are available for the following units:

216-U-1 and 216-U-2 Cribs—The highest gross gamma counts are noted about 3 m (10 ft) below the projected base of the cribs in Well 299-W19-11. This well is located about 10 m (33 ft) east of the center of the 216-U-1 Crib. The maximum activity noted in this well was 4,000 pCi/g ^{137}Cs at about 5 m (16 ft) below the projected bottom of the crib. Slightly elevated gross gamma counts were also observed in a 30 m (98 ft.) silty layer in Well 299-W19-3 about 50 m (164 ft) southeast of the crib. The gross gamma count is one to two orders of magnitude less in 299-W19-3 than in 299-W19-11. Thin, discontinuous silty layers are commonly noted in the wells surrounding the 216-U-1 and 216-U-2 Cribs. None of the other wells surrounding the cribs show evidence of anthropogenic radionuclides. Although no evidence of deep radionuclide migration can be found in the gamma logs from around these cribs, uranium is known to have reached the groundwater in this area. As described in the AAMSR about 1,510 lb of uranium was removed from the groundwater beneath the 216-U-1 and 216-U-2 cribs. The migration of contaminants through the caliche layer to the groundwater is the results of a complex series of events that are summarized on Figure 4-4.

216-U-8 Crib—Highly elevated gross gamma counts were logged in Well 299-W19-71 located in the south end of the crib. The gamma readings are highest at the base of the crib and decrease with depth to approximately 10 m (38 ft) below the crib. Wells surrounding the crib do not show evidence of anthropogenic radionuclides.

216-U-12 Crib—Highly elevated gross gamma counts were noted in Well 299-W22-75 at the south end of the crib. The gross gamma readings are highest at the base of the crib and decrease with depth to approximately 10 m (33 ft) below the crib. Spectral gamma logging indicated the maximum activity in this well was 5,000 pCi/g ^{137}Cs beginning immediately below the bottom of the crib. The spectral gamma logging also noted uranium contamination of up to 400 pCi/g as deep as 20 m (66 ft) below the crib. Well 299-W22-73 on the north end of the crib also has elevated gross gamma counts although much less than 299-W22-75. None of the wells surrounding the crib had elevated gross gamma counts.

4.2.1.2.6 Conclusions from Previous Studies. There are several general conclusions to be drawn from these previous studies:

(1) Maximum radionuclide contaminant concentrations should be expected directly beneath the main discharge points of the units.

(2) Radionuclide contamination is not expected to spread laterally more than 30 to 45 m (98 to 150 ft) beyond the point of discharge and should be at much lower concentrations than those noted beneath the center of the discharge point.

(3) Radionuclide contamination decreases rapidly with depth. The highest concentrations should occur within 2 or 3 m (7 to 10 ft) of the bottom of the discharge point and concentrations should be near background levels at 20 m (65 ft) depth. Contaminants disposed along with acidic waste will tend to migrate more deeply than contaminants disposed with basic waste.

(4) The maximum lateral radionuclide contaminant movement tends to occur immediately above relatively impermeable horizons.

(5) Radionuclide contaminants should be concentrated in fine-grained horizons compared to surrounding coarse-grained horizons because they are sorbed by fine-grained sediments.

(6) Perched water zones are most likely to occur immediately above the caliche layer. With rapid loading, perch water may extend from the caliche layer up into the lower Hanford formation. Significant lateral water and contaminant movement may occur in such a situation.

(7) The caliche layer is an important physical and chemical barrier to vertical contaminant migration and may significantly retard vertical contaminant movement. This barrier may locally be breached by large-scale fracturing, small gaps in the caliche, or by wells that offer a fluid migration pathway.

(8) Chemical contaminant distribution tends to mimic radionuclide distribution.

These general conclusions have been applied to two waste management units to illustrate expected contaminant distributions in the subsurface. Figure 4-4 is a conceptual model of contaminant distribution below the 216-U-1 and 216-U-2 Cribs. This is a more complicated sequence of events than has occurred at the other cribs because of the introduction of acid late in the crib's existence and because of the subsequent contaminant remobilization by water from the 216-U-16 Crib. For a typical crib, only step one on Figure 4-4 applies and contaminants are concentrated immediately below the crib bottom.

Figure 4-5 is a conceptual model of contaminant movement and distribution beneath the 216-U-10 Pond. Again, the majority of contaminants are held in the soils immediately beneath the pond bottom. Localized, low contaminant concentrations may occur in deeper fine-grained stratigraphic horizons. Unlike the 216-U-1/216-U-2 Cribs, the caliche layer beneath the 216-U-10 Pond acts as a physical and chemical barrier to deeper contaminant movement. Waste water does percolate through the layer to the unconfined aquifer, but very few dissolved contaminants have reached the groundwater.

The drilling programs at the cribs, french drains, and reverse wells were designed to account for these expected contaminant distributions. To encounter the most contaminated sediments, drill holes will be placed as close as possible to the liquid waste discharge points. Drilling will not be conducted outside facility boundaries because much less contamination is expected there. Sampling will be concentrated directly below discharge points because this is where contaminants are concentrated. Borings will extend to the caliche layer because this is where perched water is likely to occur.

4.2.1.3 Limited Field Investigation and Analog Unit Selection. As described in Section 1.0, the LFI process will be accomplished using a limited number of analog units selected to represent a larger group of similar units. A series of criteria has been developed to make these comparisons and to ensure that each unstudied unit has a representative analog unit. These criteria are summarized below:

(1) Are the units at the same depths and underlain by a similar stratigraphic sequence? Units were contaminants are released at greater depths below the surface are less likely to be subjected to recharge from seasonal precipitation and evapotranspiration cycles, and are less likely to be influenced by deep rooting plants. The stratigraphic horizon immediately below the discharge point of a facility is significant because fine-grained horizons will inhibit the downward migration of contaminants much more than coarse-grained horizons. The deeper stratigraphy beneath the discharge point will also influence vadose zone contaminant distribution and the likelihood of contaminants reaching the water table. A sequence dominated by fine-grained units will inhibit the downward movement of groundwater and contaminants. Impermeable units may cause perched water zones to form and cause significant lateral migration of the waste water. The caliche layer is significant in this case because it is the most laterally continuous aquitard in the vadose zone. The "Palouse" soil is important because as a loess, it inhibits the lateral movement of water perched above the caliche layer. Carbonate in the vadose zone also acts as a chemical barrier because it will buffer pore water to a nearly neutral pH, and the solubilities of most of the radionuclides are pH dependent. The vertical distribution of contaminants beneath the discharge is thus highly dependent upon the underlying units.

(2) Is the depth to groundwater comparable for the units? The depth to groundwater beneath the point of discharge will influence the probability of contaminants reaching the unconfined aquifer. A thick underlying vadose zone will be more likely to adsorb contaminants from downward migrating water before it reaches the groundwater. A thin vadose zone is less likely to fully adsorb the contaminants and would be more likely to allow contaminants to reach the unconfined aquifer.

(3) Are the total discharges to the units comparable, are the total discharges/plan view areas (i.e., loading) comparable, and are the total discharges/plan view areas/time (loading rate) comparable? Heavy loading of water into the vadose zone will enhance the downward movement of contaminants. Units that received large liquid volumes concentrated in small areas are more likely to have flushed contaminants through the vadose zone than units that received small liquid fluxes. Swift downward groundwater movement and perched water formation are more likely to occur at facilities with high loading rates. Both of these effects will tend to increase contaminant migration rates.

(4) Do the units have similar waste inventories? Units that received large radionuclide inventories will naturally tend to be underlain by larger volumes of contaminated soils and to have higher contaminant concentrations. Because of solubility and soil retention characteristics, different contaminants will also tend to migrate at different rates.

(5) Did the units receive materials that could aid contaminant migration, such as acids or organic solvents? The distance that contaminants will travel in the vadose zone depends on how strongly they are partitioned to the soils that are in contact with the transporting solution. Acids or solvents that keep contaminants in solution may transport contaminants farther from the point of discharge than they would normally travel.

Once each set of similar units has been identified, the worst-case units from that set will be selected for study. The worst-case units are those where one would expect the highest contaminant concentrations, the largest contaminant inventories, and the greatest likelihood for contaminant migration to groundwater. The regulatory setting is also considered when selecting units for study. Waste management units that are subject to more stringent regulations will be studied if possible.

In Sections 4.2.2 through 4.2.6, the selection process outlined above is applied on a waste management unit-specific basis. The rationale for activities that are not directly related to a single waste management unit are described under Section 4.2.7, Other Field Investigations.

4.2.2 Tanks and Vaults

The 241-U-361 Settling Tank is within the stabilized area surrounding the 216-U-1 and 216-U-2 cribs and is part of the process line that fed the cribs. For this reason, it is being studied along with the cribs. Unplanned Release UN-200-W-19 is adjacent to the tank and is within the stabilized area surrounding the cribs, so it too will be studied in conjunction with cribs.

A surface radiological survey and surface soil sampling is needed to identify potential contamination over the tank. Although the tank reportedly contains liquid, there is no evidence of it leaking. Sampling of the tank contents is not recommended at this time. Sampling the tank contents will yield little additional information about the nature and extent of contamination in the surrounding soils. Tank sampling should be done in preparation for waste removal, however, which is outside the scope of this LFI.

4.2.3 Cribs

The selection of crib analog units for the LFI is described in Section 4.2.3.1. The rationale for the selection of field activities is described in Section 4.2.3.2.

4.2.3.1 Analog Unit Selection. This section describes the selection of analog units from the five cribs in the 200-UP-2 Operable Unit. In addition, the 216-U-3 French Drain is considered a potential crib analog because of similarities in its construction and disposal history. The french drain is actually a gravel filled excavation 3.6 m (12 ft) deep and 1.8 m (6 ft) wide at the base. The sides of the excavation have a 3:1 slope, so the actual lateral dimensions of the unit are much broader. The size and shape of this unit are more similar to a crib than to other french drains. Two of the five cribs in the 200-UP-2 Operable Unit have been selected for detailed study (216-U-1/216-U-2 and 216-U-8). The percentage of cribs selected for study is higher than the percentage expected in other operable units for several reasons:

(1) The limited number of cribs within the operable unit made it difficult to find comparable analog units. In an operable unit with a larger numbers of cribs, studying two cribs may be sufficient to characterize two or three times as many units.

(2) This is the first operable unit at which the analog study technique has been proposed. To gather supporting data for the technique, more units are proposed for study at the 200-UP-2 Operable Unit than may be necessary in the future.

The selection process was made according to the criteria listed in Section 4.2.1.3. The individual criteria are described below and are summarized on Table 4-1.

(1) Are the units at the same depths and underlain by a similar stratigraphic sequence? The cribs and french drain vary from 3 to 9.4 m (10 to 31 ft) deep. They are all in the Upper Coarse Member of the Hanford formation and are underlain by sands or gravels. The stratigraphic positions of the units are similar enough to allow analog comparisons. The deeper vadose zone stratigraphy for each unit was compared using the stratigraphic block diagrams (Figures 2-3 through 2-5), the composite stratigraphic columns (Figures 2-6 through 2-16), and the structure contour and isopach maps presented in Section 3.0

of the U Plant Source AAMSR. The stratigraphy beneath the cribs is similar enough for analog comparisons to be made. Most importantly, the Plio-Pleistocene caliche layer is present beneath each of the facilities. This is the primary aquitard in the vadose zone and is an important control on the movement of contaminants. The early "Palouse" soil is another important unit and it is also present beneath each unit.

(2) Is the depth to groundwater comparable for the units? The depth to groundwater beneath the units varies between approximately 58 to 67 m (190 to 220 ft). The thickness of the vadose zone beneath the units thus varies by less than 15%. This is considered small enough for valid comparisons to be made.

(3) Are the total discharges/plan view area (loading) comparable and are the loading rates comparable? The loading is comparable at each of the units except for the 216-U-1/216-U-2 Cribs, which are more than an order of magnitude higher than any of the other facilities (Table 4-1). The loading rate at the 216-U-1/216-U-2 Cribs is also higher than at any other facility. The 216-U-17 Crib is still active and may receive more liquid waste in the future, so the final total loading cannot be calculated.

(4) Do the units have similar waste inventories? The waste inventories listed in the U Plant Source AAMSR were studied and some major differences were found between units. The 216-U-8 Crib received much more plutonium, uranium and total alpha contamination than any of the other cribs. In fact, the unit has a larger uranium inventory than any other crib in the 200 West Area. According to inventory data, the 216-U-1/216-U-2 Cribs received two orders of magnitude more ^{137}Cs than any other crib and also received large quantities of plutonium. The 216-U-16 and 216-U-17 Cribs and the 216-U-3 French Drain received relatively minor inventories of all radionuclides. The 216-U-12 Crib reportedly received an order of magnitude more ^{90}Sr than any other crib. However, its other radionuclide constituents are significantly less than those found in the 216-U-1/216-U-2 and 216-U-8 Cribs. The worst-case units for contaminant concentrations will thus probably be the 216-U-1/216-U-2 and 216-U-8 Cribs.

(5) Did the units receive materials that could aid contaminant migration, such as acids or organic solvents? Contaminants beneath the 216-U-1/216-U-2 Cribs are known to have been mobilized to the groundwater by introducing acid wastes and excessive water loading at the nearby 216-U-16 Crib. The 216-U-8 Crib received approximately 379,000 L (100,000 gal) of acidic process condensate and 200,000 kg (441,000 lb) of nitric acid. The 216-U-12 Crib received waste from the acidic ($pH < 1$) UO_3 Process Condensate System. The 216-U-16 and 216-U-17 Cribs and the 216-U-3 French Drain are not thought to have received any wastes that could aid in contaminant migration. The worst case units for contaminant migration will probably be the 216-U-1/216-U-2, 216-U-8, and 216-U-12 Cribs.

All of the cribs and the 216-U-3 French Drain are comparable according to the geographic and hydrogeologic criteria (items 1 to 3 above). The inventory criteria (items 4 to 6), however, indicate that many of the units are not directly comparable, so the worst-case cribs were selected for study. The 216-U-1/216-U-2 Cribs were selected because they have large plutonium and cesium inventories, because they are calculated to have had such a large loading and loading rate, and because contaminant migration to the groundwater has occurred there. The 216-U-1/216-U-2 Cribs are also being studied because they have the second highest ^{90}Sr inventories and so in this respect are most comparable to the 216-U-12 Crib. The 216-U-8 Crib was selected for study because it has very large plutonium and uranium inventories and received acidic waste. The 216-U-16 Crib was designated as an analog unit because it received a relatively small waste inventory and is thought to be free of any acid waste. However, its contribution to contaminant migration at 216-U-1/216-U-2 Cribs will be investigated by an additional deep boring between the 216-U-1/216-U-2 and 216-U-16 Cribs. The 216-U-17 Crib is an active facility, so is not included in this study. The crib is hydrogeologically analogous to the other cribs, however. If the comparison criteria are still comparable when the crib is closed, it is recommended that the 216-U-17 Crib be considered an analog to the 216-U-8 Crib. The 216-U-12 Crib is considered analogous to the 216-U-8 Crib. The 216-U-12 Crib was the replacement unit that began operation after the 216-U-8 Crib was closed, and it received waste from similar sources. Its higher ^{90}Sr content is considered comparable to the 216-U-1/216-U-2 Cribs. The 216-U-12 Crib's loading and loading rate is also comparable to these other cribs. The 216-U-3 French Drain was designated as an analog because it received a relatively small waste inventory and is thought to be free of any acidic waste.

Additional field work is also planned at the 216-U-12 crib because it received an RCRA waste (according to corrosivity). The field data collected will be used to show that the acidic waste has been neutralized, and that this facility should not be covered by RCRA and so may be studied along with the other cribs.

4.2.3.2 Field Activity Rationale. This section describes the selection rationale for field activities and procedures at the 216-U-1/216-U-2 and 216-U-8 Cribs. The primary activity at each of these facilities will be to sample while drilling through the cribs. All of these studies will involve drilling through contaminated sediments under the waste disposal facilities.

At each of the cribs, one drill hole is planned as close as possible to the main process line. These holes are expected to intersect the most intensely and deeply contaminated vadose zone sediments at each of the units according to the predictions made in Section 4.2.1.2. Each hole should extend to the caliche layer so that, if necessary, a perched water well can be installed and water samples taken. Borings should not extend through the caliche layer because there is a danger they could open a pathway for contaminant migration through the layer. The sampling effort at each unit will be concentrated in the upper part of boring where the highest concentrations are expected. Less frequent sampling will continue to the caliche layer because contaminants may also be concentrated immediately above this impermeable layer. Two additional holes are planned in the vicinity of the 216-U-1/216-U-2 Cribs. These holes are necessary to help delineate the lateral extent of contamination beneath the facility because of its special waste disposal history. The 216-U-1/216-U-2 Cribs are a special case because uranium is known to have reached the groundwater beneath them during a release in 1984 and 1985 (Figure 4-4). The boring to the north of the 216-U-1/216-U-2 Cribs is adjacent to the 2607-W-5 Septic Tank and Drain Field. This boring is also intended to determine if perched water zones may be forming beneath this active drainfield. If perched water zones do exist, they could be remobilizing contaminants beneath the cribs (Figure 4-4). Data from this boring may also be used during future RI activities to determine if the drainfield has contributed contaminants to the area. Only one drill hole is planned at the 216-U-8 Crib because the previous studies at other cribs have shown that normally contaminants show very little lateral movement. The limited lateral extent of contamination at each of these facilities will be confirmed, in part, by running spectral gamma geophysics on nearby wells. Spectral gamma logging will also be conducted on the new borings to better define the vertical extent of contaminants between the sampled intervals. Surface contamination will also be identified and delineated at each of the three cribs by surface radiation surveys and surface soil sampling.

A boring is also planned adjacent to the 216-U-12 crib in order to characterize the pH and buffering capacity of the soil column beneath the crib.

4.2.4 Drains and Reverse Wells

The french drains and reverse wells in the 200-UP-2 Operable Unit were selected for LFIs in the U Plant Source AAMSR. The selection of analog units for the LFI is described in Section 4.2.4.1. The rationale for the selection of field activities is described in Section 4.2.4.2.

4.2.4.1 Analog Unit Selection. As described in Section 4.2.3, the 216-U-3 French Drain was designated as a crib analog unit. Two of the five waste management units in this group have been selected for detailed study (216-U-4 and 216-U-4A). These units were selected according to the criteria listed in Section 4.2.1.3. The selection process is described below and is summarized on Table 4-2.

(1) Are the units at the same depths and underlain by a similar stratigraphic sequence? The french drains vary in depth from 1.2 to 6.1 m (4 to 20 ft). They are all in the Upper Coarse Member of the Hanford formation. The 216-U-4 Reverse Well is 23 m (75 ft) deep and extends to near the contact of the Upper Coarse and Lower Fine Unit of the Hanford formation. The stratigraphic position of the reverse well is not close enough to the French drains to allow comparison. The top of the unconfined aquifer

beneath each unit is in the Ringold Formation. The vadose zone stratigraphy for each unit was compared using the stratigraphic block diagrams (Figures 2-3 through 2-5), the composite stratigraphic columns (Figures 2-6 through 2-14) and the structure contour and isopach maps presented in Section 3.0 of the AAMSR. The stratigraphy beneath the cribs is considered similar for making analog comparisons. The early "Palouse" soil and the Plio-Pleistocene caliche units are present beneath each facility.

(2) Is the depth to groundwater comparable for the units? The depth to groundwater beneath the units varies from about 60 m (197 ft) beneath 216-U-4 to about 84 m (276 ft) beneath the other facilities. This means the thickness of the vadose zone beneath the two sets of units varies by about 30%. This is considered too high for valid comparisons to be made.

(3) Are the total discharges/plan view area (loading) and loading rates comparable? The calculated loading and loading rates for each of the units are summarized on Table 4-2. The loading is much higher at 216-U-4 and 216-U-4A than the other units. The loading rate at the 216-U-4 Reverse Well is one to two orders of magnitude higher than at all other units.

(4) Do the units have similar waste inventories? The units all received comparable waste inventories except for 216-U-7 French Drain, which reportedly received 140 kg (309 lb) of uranium during a 1953 unplanned release. Based upon the isotopic ratios of uranium found elsewhere in the Hanford environment this correlates to approximately 0.1 Ci of total uranium. No other radionuclide inventory data are available for the 216-U-7 French Drain, but it only received 7,000 L (1,850 gal) of total waste, one to two orders of magnitude less than the other drains and reverse wells. Contaminant concentrations and extent around the 216-U-7 French Drain are believed to be less than around the other waste management units.

(5) Did the units receive materials that could aid contaminant migration, such as acids or organic solvents? The 216-U-4A French Drain reportedly received acidic waste. None of the other units are thought to have received waste that could aid contaminant migration.

A review of the above criteria shows that two units will require study. The 216-U-4 Reverse Well will be studied because it is located in a different stratigraphic horizon, the depth to groundwater is less, and its loading and loading rates are much higher than the other units. The 216-U-4A French Drain will be studied as an analog of the 216-U-7 and 216-U-4B French Drains. Contaminant migration is more likely at 216-U-4A than the other two facilities because it received larger volumes of liquid waste and because it received acid waste.

4.2.4.2 Field Activity Rationale. This section describes the selection rationale for field activities at the 216-U-4 Reverse Well and the 216-U-4A French Drain. As with the cribs, the drilling program for these facilities was designed after reviewing the data from the 216-Z-1A and 216-Z-9 Cribs and the 200-BP-1 Operable Unit (Section 4.2.1.2). The primary conclusions to be drawn from these studies are that lateral contaminant migration is minimal and the contamination is concentrated immediately beneath the point at which it is introduced to the soil.

Borings at each of the facilities should be placed as close as possible to the center of the liquid discharge point to encounter the highest contaminant concentrations. The 216-U-4 Reverse Well and 216-U-4A French Drain are only 3 m (10 ft) apart, so only one boring should be necessary to characterize both units. The discharge points for these two units are separated vertically by 21 m (64 ft). Based on previous studies (Section 4.2.1.2), it is expected that two distinct contaminant zones will be intersected. The borings will have to extend as far as the caliche layer so that perched water wells can be installed if necessary.

Sampling should be concentrated in the intervals immediately below the discharge points of each unit because this is where the highest contaminant concentrations are expected. Surface contamination at each of the waste management units will be identified and delineated by radiological surveys and surface soil sampling.

4.2.5 Ponds, Ditches, and Trenches

The 216-U-10 Pond and its associated ditches (216-U-11, 216-U-14, 216-Z-1D, 216-Z-11, and 216-Z-19) will undergo a limited confirmatory sampling program.

The 216-U-10 Pond System was studied in detail before its closure. The lateral distributions and concentrations of the primary radionuclide contaminants of concern were mapped during these earlier studies. The primary data gaps from these earlier studies were identified: (1) the lack of analytical data for potential nonradionuclide contaminants and for less common radionuclides, and (2) the paucity of data describing the vertical extent of contamination. The first data gap will be addressed by a test pit in the 216-U-10 Pond delta area. This boring is located at the point where each of the ditches emptied into the 216-U-10 Pond, so it will sample soils impacted from all potential sources. Also, the previous studies indicate that this is the most highly contaminated area in the 216-U-10 Pond and the highest contaminant concentrations should be encountered here. Samples from this boring should be sampled for the full suite of target analytes to determine if there are contaminants of concern in addition to those already identified in the prior studies. The second data gap will be addressed by the excavation of a test pit in the center of the 216-U-10 Pond. This test pit is located in an area of maximum water infiltration during the ponds operational life. Sampling at this test pit is designed to confirm that the vast majority of contaminants are held in the upper 3 or 4 m (10 ft or 13 ft) of the soil column (Section 4.2.1.2). Surface radiation surveys and surface soil sampling will also be needed to test the effectiveness of the existing soil cap and to define the lateral extent of any surface contamination.

4.2.6 Basins

The 207-U Retention Basin will be studied in conjunction with the 216-U-10 Pond and its associated ditches. The basin received wastewater that fed directly into the 216-U-14 Ditch and ultimately into the 216-U-10 Pond. Surface contamination needs to be identified and delineated by surface radiological surveys, soil sampling, and sediment sampling. The basin is not reported to have leaked, so borings to characterize contamination under the facility are not a high priority. Borings may be performed during later post LFI characterization activities however. Subsurface contamination is known to exist and therefore needs to be characterized at the adjacent, associated unplanned releases. The unplanned releases have similar sources and histories, so only one test pit will be required to characterize both. The test pit should be located by surface radiological and geophysical results.

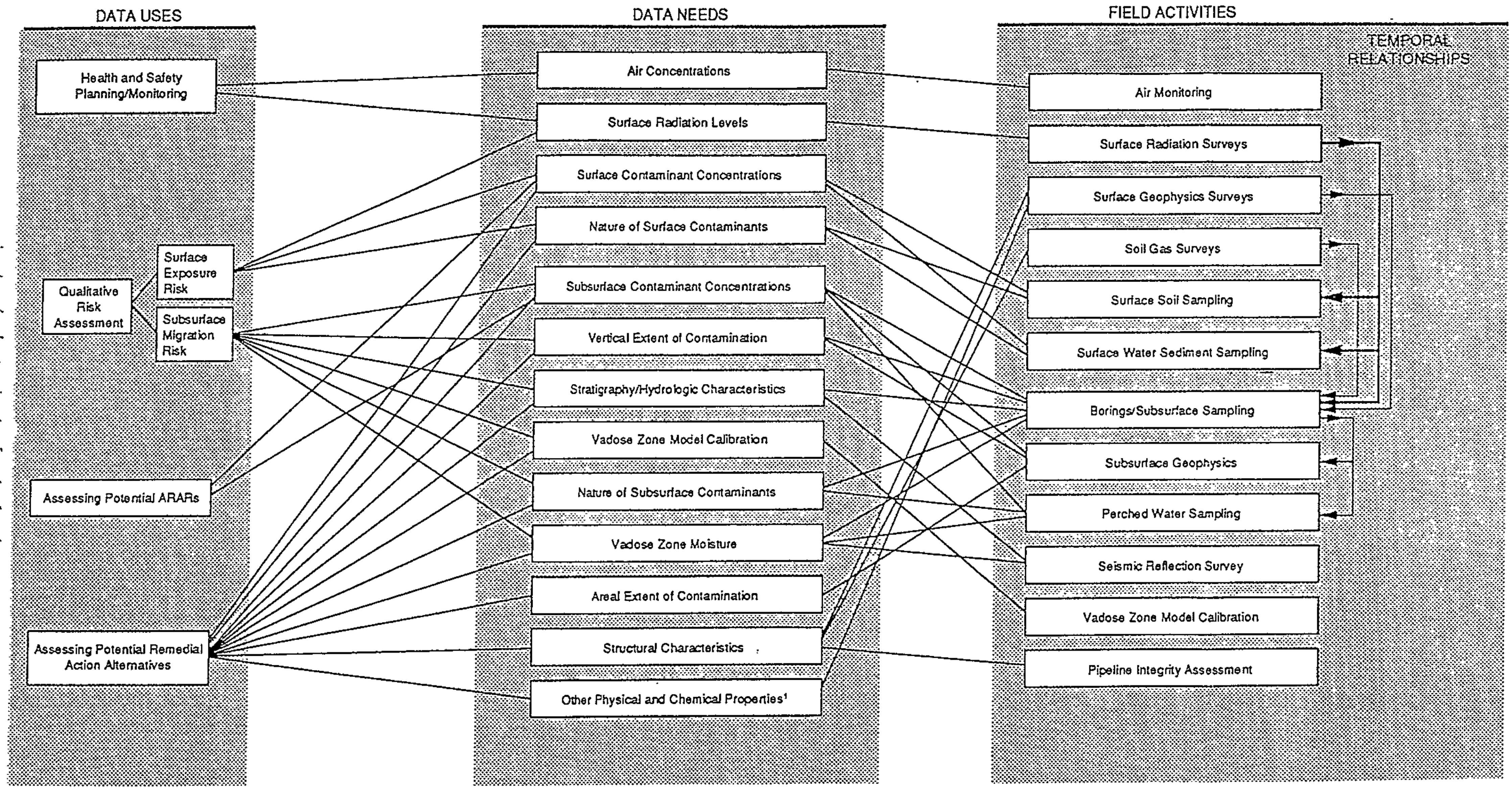
4.2.7 Other Field Activities

There are several field activities that are not unit-specific, but they must be performed to satisfy the identified data uses and needs.

Air monitoring is required to determine contaminant air concentrations for health and safety monitoring during field operations and to assess the potential for windborne contaminant migration.

Pipeline integrity assessments need to be conducted to identify leak points in the inactive process pipelines associated with the analog units selected for study. Camera surveys of the piping should be made, if possible, in conjunction with surface radiation surveys. If one or both of these surveys identify potential leak points, they should be investigated with test pits. The test pits will need to be excavated to the base of the pipeline and the surrounding soil will need to be sampled to determine the nature and extent of the pipeline leak. Vitrified clay pipes may have leaked over their entire length. Along these types of pipelines, test pits should be made at the most highly contaminated leak points to examine a "worst case" condition and at a point where no leak is indicated to examine the "average" conditions surrounding the vitrified clay pipes.

Data will be collected to support the calibration/validation of vadose zone flow and transport models for the 200 West Area. The M-29-02 milestone document outlines the strategy for calibration/validation of vadose zone flow and transport models. The data needs for the modeling effort listed in this document include physical parameters, hydrologic properties, and soil chemistry parameters. Detailed information of this sort will be gathered from a single borehole in the operable unit. The borehole should extend to groundwater and samples should be collected to characterize each lithology and hydrologic condition encountered. The difficulty of performing these analyses will be greatly reduced if the samples are uncontaminated, therefore the borehole should be located in a centrally located area that is thought to be free of contamination. A limited number of detailed physical samples should also be taken from the deep borings at the individual waste management units. These samples will be used to investigate the lateral variation of chemical and physical parameters within individual stratigraphic units.



[1] Specialized data needs for specific remediation alternatives will be addressed in feasibility studies.

Figure 4-1. Relationship between Data Uses, Data Needs and Field Activities

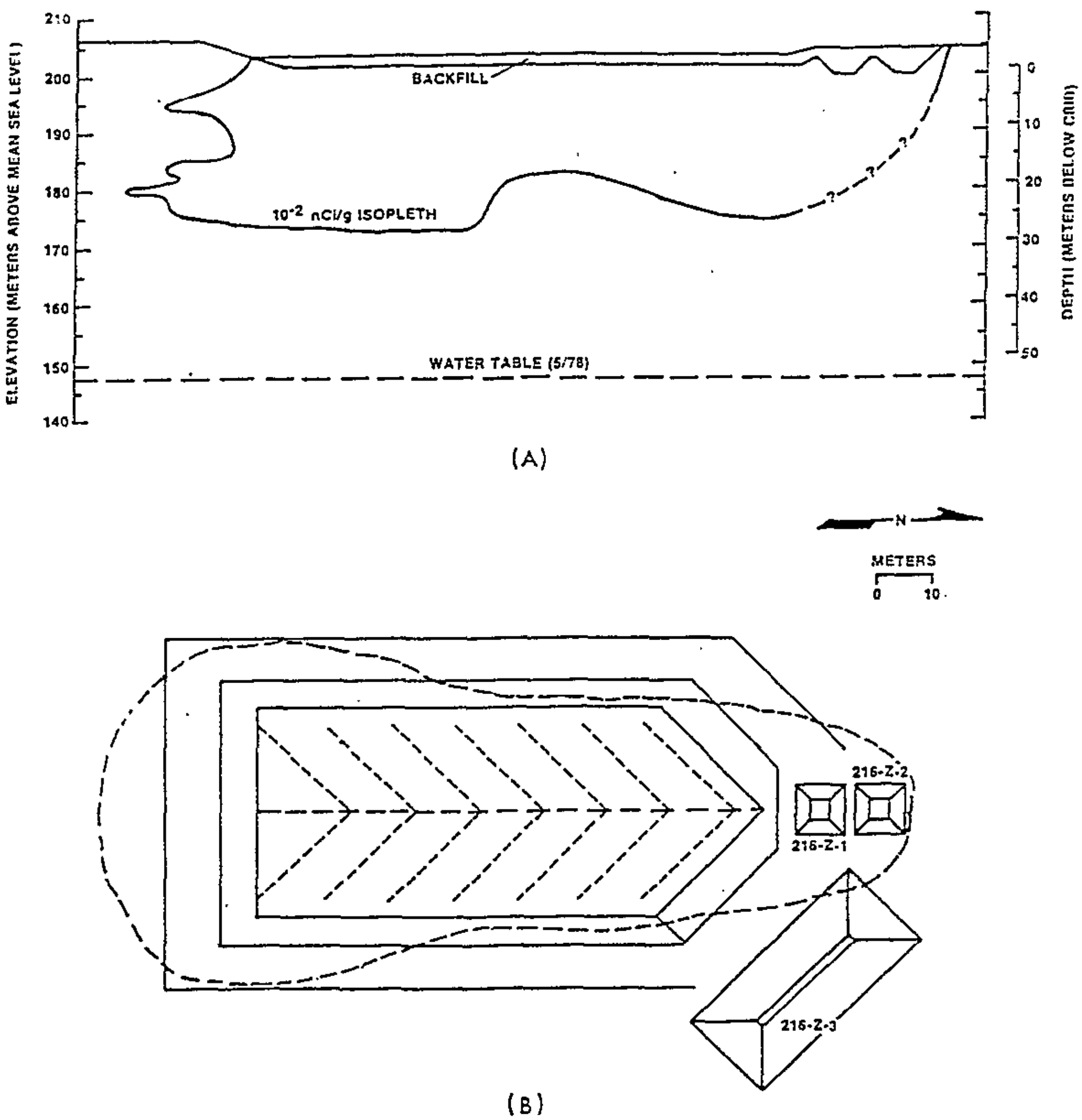


Figure 4-2. Graphic Representation of Waste Plume Beneath the 216-Z-1A Crib (A) North-South Cross Section Through Center of Crib (B) Plan View of Crib.

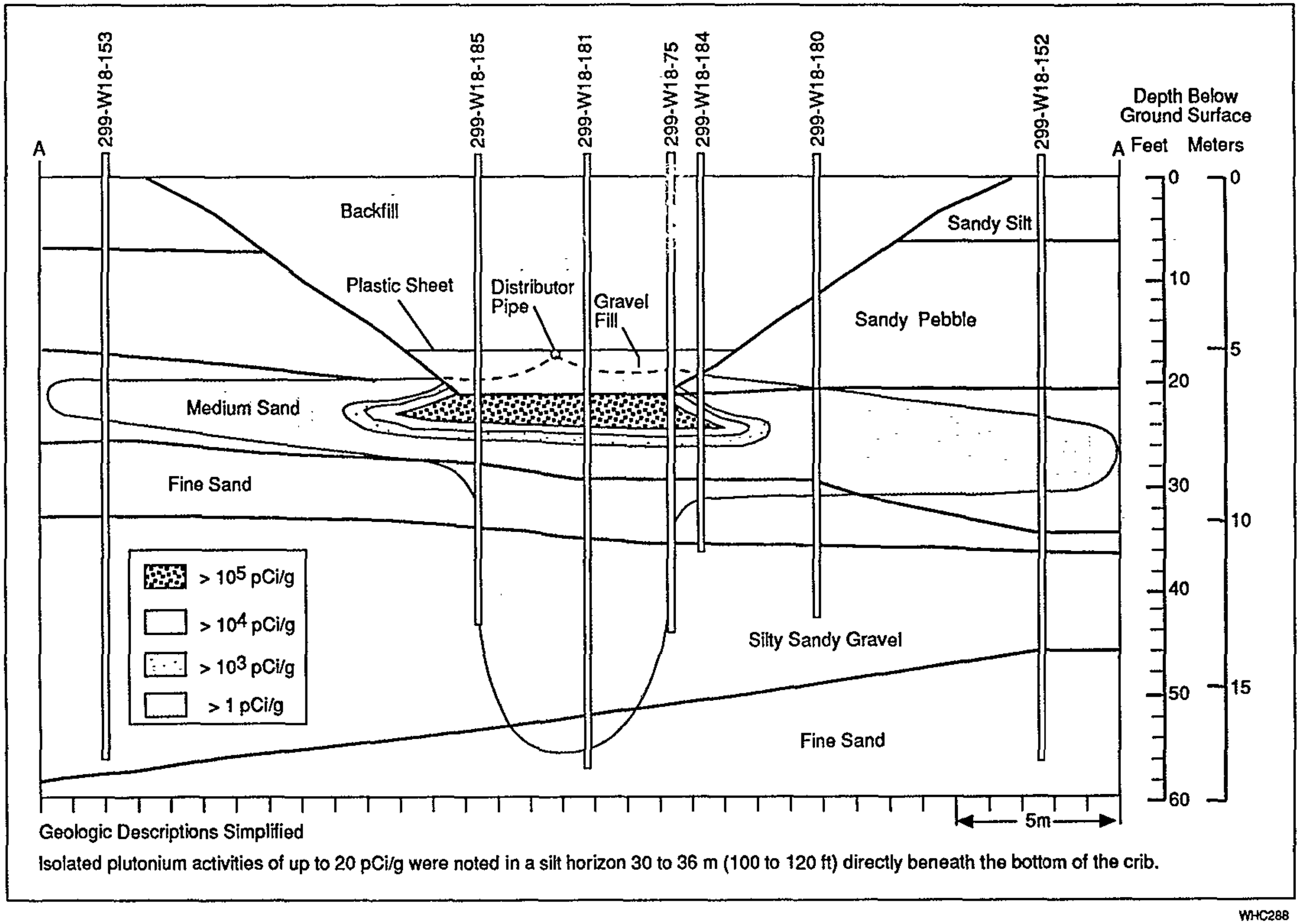
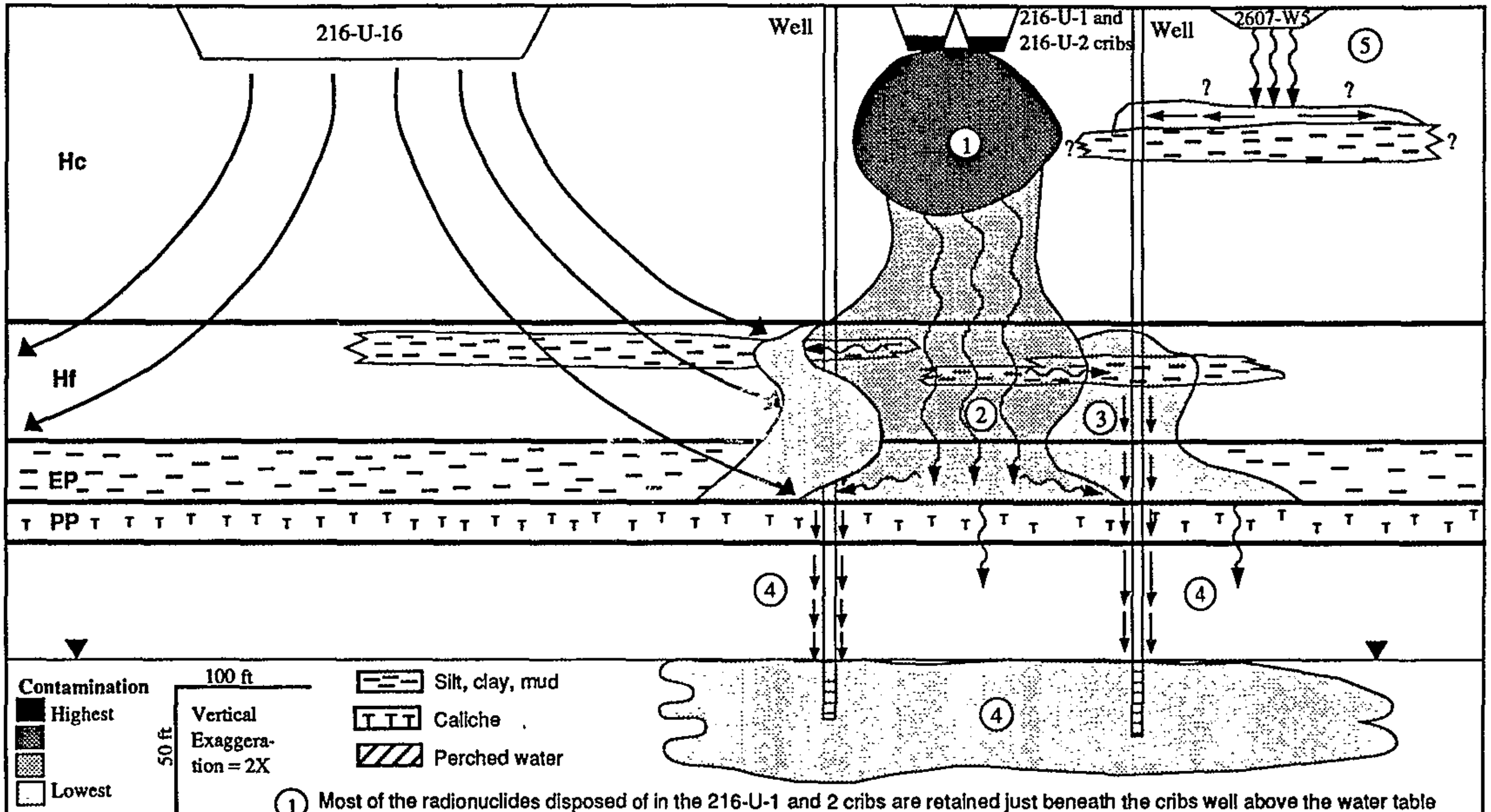


Figure 4-3. Distribution of Plutonium Activity Below the 216-Z-12 Crib (Kasper 1981).



(1) Most of the radionuclides disposed of in the 216-U-1 and 2 cribs are retained just beneath the cribs well above the water table and caliche layer and potential perched water zone. Locally, low contaminant concentration may occur at greater depths in fine-grained layers.

(2) Acid waste from scavenging operations discharged to the cribs causes uranium to become soluble. Some of the soluble uranium and other radionuclides migrate with the liquid discharge to the top of the impermeable caliche layer. Contamination becomes immobile because quantity of fluid is limited.

(3) Large volumes of water discharged to the 216-U-16 crib spread laterally along the top of the caliche layer (PP). This perched water spreads beneath the 216-U-1 and -2 cribs picking up soluble uranium and moving it laterally.

(4) Perched water with soluble uranium reaches the groundwater via poorly sealed monitoring wells or through cracks in the caliche. The subsequent pumping and treatment of aquifer water removed much of this uranium.

(5) Potential perched water formation below 2607-W5 septic tank and drain field has a small potential to remobilize contaminants.

Figure 4-4. Conceptual Model of Contaminant Movement and Distribution Below the 216-U-1 Crib.

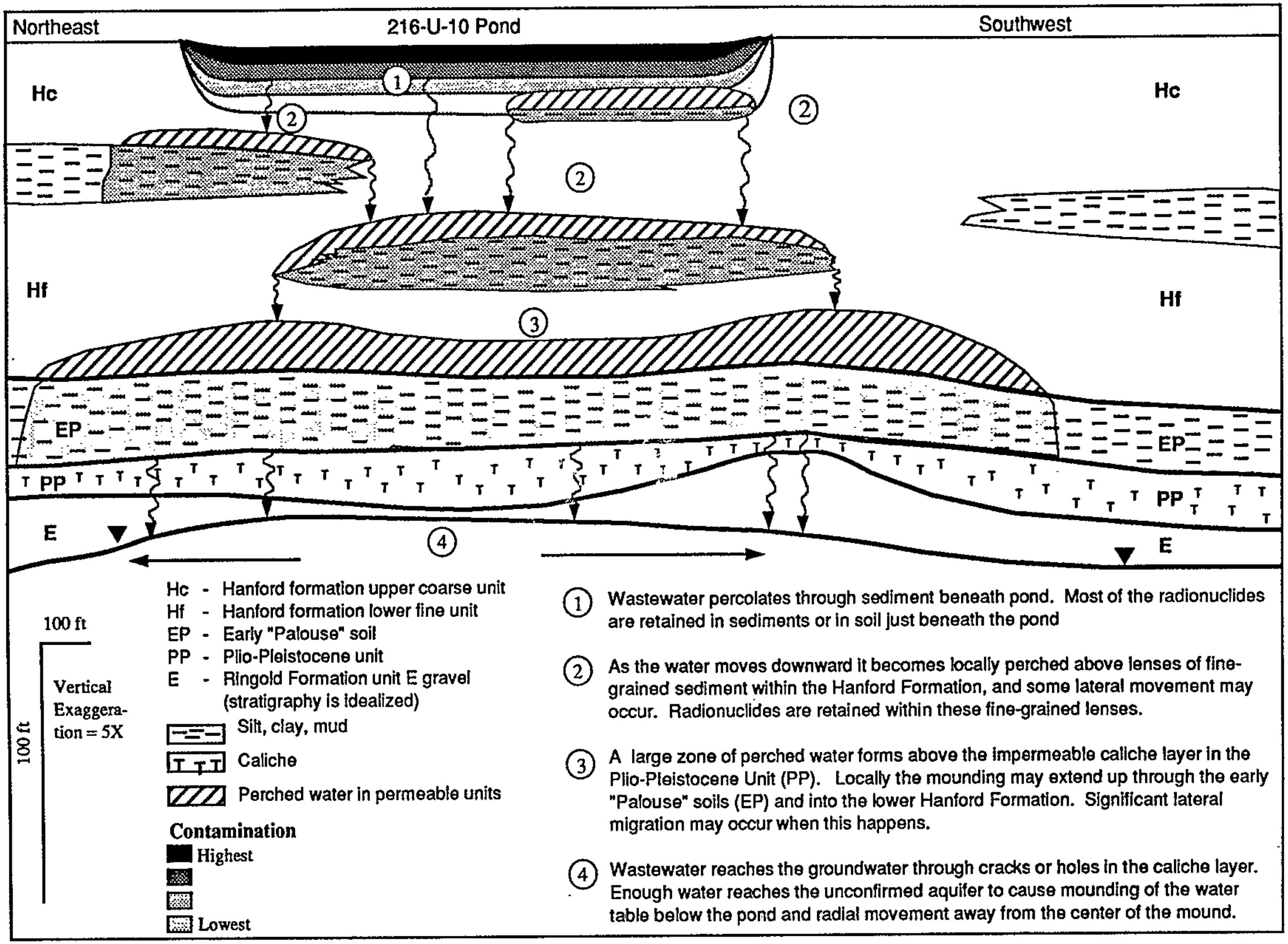


Figure 4-5. Conceptual Model of Contaminant Movement and Distribution Below the 216-U-10 Pond.

Table 4-1. Analog Unit Comparison for Cribs and the 216-U-3 French Drain.

	216-U-1/U-2[d]	216-U-8[d]	216-U-12	216-U-16	216-U-17	216-U-3
1) Unit Depths						
Depth	6.1 m (20 ft)	9.4 m (31 ft)	6 m (20 ft)	5 m (16 ft)	5.5 m (18 ft)	3.6 m (12 ft)
Stratigraphic Host	Upper Coarse Unit	Upper Coarse Unit	Upper Coarse Unit	Upper Coarse Unit	Upper Coarse Unit	Upper Coarse Unit
Stratigraphy						
Early Palouse (depth/thickness)[a]	40 m/4 m (131 ft/13 ft)	47 m/4 m? (154 ft/13 ft?)	52 m/6 m? (171 ft/20 ft?)	44 m/3 m? (144 ft/10 ft?)	46 m/5 m (151 ft/16 ft)	39 m/3 m (128 ft/10 ft)
Plio-Pleistocene (depth/thickness)[a]	44 m/3 m (144 ft/10 ft)	57 m?/3 m? (187 ft?/10 ft?)	58 m?/6 m? (190 ft?/20 ft?)	47 m?/3 m? (154 ft?/10 ft?)	51 m/5 m (167 ft/20 ft)	42 m/1.5 m (138 ft/5 ft)
2) Depth to Groundwater[a]	62 m (203 ft)	62 m (203 ft)	66 m (217 ft)	62 m (203 ft)	61 m (200 ft)	57 m (187 ft)
3) Discharge/Plan View Area and Discharge/Plan View Area/Operational Life	1,890,000 L/m² (46,400 gal/ft²) 270 L/m²/day (7 gal/ft²/day)	52,500 L/m² (1,290 gal/ft²) 16 L/m²/day (0.4 gal/ft²/day)	170,000 L/m² (4,170 gal/ft²) 15 L/m²/day (0.4 gal/ft²/day)	37,100 L/m² (910 gal/ft²) 120 L/m²/day (3 gal/ft²/day)	57,000 L/m² (1,400 gal/ft²) 50 L/m²/day (1 gal/ft²/day)[c]	31,000 L/m² (760 gal/ft²) 20 L/m² day (0.5 gal/ft²/day)
4) Waste Inventory Common Radionuclides and Total Volume[b]	Sr-90, Cs-137, Pu, U 46,200,000 L (12,206,100 gal)	Pu, U 379,000,000 L (100,132,100 gal)	Sr-90 150,000,000 L (39,630,120 gal)	Cs-137, Pu, H-3 409,000,000 L (108,058,100 gal)	H-3 2,110,000 L (557,460 gal)	Cs-137, Pu 791,000 L (208,980 gal)
5) Materials Aiding Contaminant Migration	Acidic Waste	Acidic Waste	Acidic Waste	None Documented	None Documented	None Documented

[a] These depths are measured from the bottom of each waste management unit.
[b] Compiled from WIDS.
[c] This unit is still active and these numbers may change in the future.
[d] Analog units selected for study.

Table 4-2. Analog Unit Comparison for French Drains and Reverse Wells.

	216-U-4[c]	216-U-4A[c]	216-U-4B	216-U-7
1) Unit Depths				
Depth	23 m (75 ft)	1.2 m (4 ft)	3 m (10 ft)	5.2 m (17 ft)
Stratigraphic Host	Upper Coarse/ Lower Fine Unit	Upper Coarse Unit	Upper Coarse Unit	Upper Coarse Unit
Stratigraphy				
Early Palouse (depth/thickness)[a]	25 m/8 m (82 ft/26 ft)	47 m/8 m (154 ft/26 ft)	45 m/8 m (148 ft/26 ft)	48 m/1.5 m? (157 ft/5 ft?)
Plio-Pleistocene (depth/ thickness)[a]	33 m/11 m (108 ft/36 ft)	55 m/11 m (180 ft/36 ft)	53 m/11 m (174 ft/36 ft)	50 m/1.5 m (164 ft/5 ft)
2) Depth to Groundwater[a]	51 m (167 ft)	73 m (239 ft)	71 m (233 ft)	67 m (220 ft)
3) Discharge/Plan View Area and Discharge/Plan View Area/ Operational Life	6,600,000 L/m^2 (162,000/ft^2) 2,000 L/m^2/day (49 gal/ft^2/day)	411,000 L/m^2 (10,000 gal/ft^2) 70 L/m^2/day (2 gal/ft^2/day)	51,000 L/m^2 (1,250 gal/ft^2) 13 L/m^2/day (0.3 gal/ft^2/day)	15,000 L/m^2 (370 gal/ft^2) 5 L/m^2/day (0.1 gal/ft^2/day)[c]
4) Waste Inventory Common Radionuclides and Total Volume[b]	Received the same waste as 216-U-4A 300,000 L (79,260 gal)	Cs-137 545,000 L (143,990 gal)	Cs-137 33,000 L (8,720 gal)	U 7,000 L (1,850 gal)
5) Materials Aiding Contaminant Migration	Acidic Waste	Acidic Waste	None Documented	None Documented

[a] These depths are measured from the bottom of each waste management unit.
[b] Compiled from WIDS.
[c] Analog units selected for study.

5.0 REMEDIAL INVESTIGATION

This section describes the activities that will occur during LFI and confirmatory sampling studies in the 200-UP-2 Operable Unit. The activities are designed to provide information to meet the data quality objectives (DQOs) identified in the U Plant Source AAMSR and discussed in Section 4.1 of this work plan.

Section 5.1 describes the work breakdown structure by which the LFI activities will be implemented. The tasks designated by the work breakdown structure will be used to manage the budget and schedule the LFI activities.

Section 5.2, Project Management (Task 1), summarizes the management activities associated with implementing the data gathering and interpretation tasks of the 200-UP-2 Operable Unit RI/FS Work Plan.

Section 5.3, Field Activities (Tasks 2 to 6), describes all of the field data gathering activities. This section is equivalent to a field sampling plan and each field activity can be conducted with guidance solely from this section. The field activities are described in terms of sampling locations and frequencies, and sampling procedures and protocols. This information is presented at the same level of detail as a typical sampling and analysis plan (SAP) because this work plan is not accompanied by a separate SAP.

Sections 5.4 through 5.7 describe the data interpretation tasks leading to the production of an LFI report. These tasks include: data evaluation (Section 5.4), qualitative risk assessment (Section 5.5), verification of ARARs (Section 5.6), and production of the LFI report (Section 5.7).

The FFS described in Section 6.0 will use the data provided during the LFI to select an appropriate IRM.

5.1 WORK BREAKDOWN STRUCTURE

This section summarizes the tasks to be implemented during LFI studies at the 200-UP-2 Operable Unit. Tasks are the primary controlling framework within which the LFI is conducted. Each task describes a primary need or goal of the LFI. The tasks control and are implemented by a series of associated subtasks and activities. Ten distinct tasks are described in this section: project management (Task 1), source characterization (Task 2), geologic investigation (Task 3), surface water sediment investigation (Task 4), vadose zone investigation (Task 5), air investigation (Task 6), data evaluation (Task 7), qualitative risk assessment (Task 8), verification of contaminant- and location-specific ARARs (Task 9), and completion of the LFI report (Task 10). Information is provided on each task to help estimate project schedules and costs.

Tasks 2 through 6 control data collection and field activities. Each of these field-related tasks is broken down into four subtasks: data compilation and review, field investigation, laboratory analysis, and data evaluation.

Data compilation and review for each of the field-related tasks was largely completed during the production of the U Plant Source AAMSR. The AAMSR presents a compilation of the historical, physical, and chemical and radiological data for the 200-UP-2 Operable Unit. Sections 2.0 and 3.0 of this work plan summarize the AAMSR data. This includes new data collected during detailed site inspections of the waste management units and unplanned releases within the operable unit. The field investigation and laboratory analysis subtasks are described in detail in Section 5.3 of this work plan. Data collected during field activities will be integrated with existing data and evaluated. Data collected during nonintrusive activities such as surface radiation surveys, surface geophysics surveys, and soil gas surveys will be evaluated immediately to help define subsequent field activities such as surface soil sampling and borehole locations. The overall data evaluation strategy is outlined in Section 5.4.

The relationship between the field-related tasks and field activities is summarized in Table 5-1. Many of the field activities are associated with more than one task. For example, the boring field activity will yield data for the source characterization, geologic investigation, and vadose zone investigation tasks.

The following sections briefly outline the nature of each task and subtask, and the activities with which they are associated.

5.1.1 Project Management (Task 1)

The objectives of project management during the implementation of the LFI Work Plan are to direct and document project activities, to ensure that data and evaluations generated meet the goals and objectives of the work plan, and to administer the LFI/FFS within budget and schedule. The initial project management activities will be to assign individuals to roles established in the Project Management Plan (PMP) of the U Plant Source AAMSR. The project management task is detailed in Section 5.2.

5.1.2 Source Characterization (Task 2)

The purpose of the source characterization is to (1) determine the exact locations and boundaries of the waste management units and unplanned releases, (2) conduct document reviews, surveys, and sampling of source material to verify the presence and content of hazardous, radioactive or mixed waste, and (3) collect surface and near-surface chemical and radiological data for use in a qualitative risk assessment.

The subtasks and field activities that are associated with the source characterization at each waste management unit are summarized in Table 5-2. The majority of source characterization data will be collected during nonintrusive activities such as surface geophysics and surface radiation surveys, and boring and test pits field activities. The source characterization activities are described in detail in Section 5.3.

5.1.3 Geologic Investigation (Task 3)

The primary purpose of the geologic investigation is to characterize the geologic conditions that can influence the occurrence, distribution, and migration of contaminants in the subsurface. The stratigraphy of the vadose zone above the caliche layer is of particular interest. The geologic investigation mainly addresses geologic and hydrogeologic conditions; the actual extent of vadose zone contamination above the caliche is addressed by the vadose zone investigation (Task 5).

The major emphasis of the geologic investigation is to characterize the stratigraphy of the vadose zone above the caliche layer, and to collect other geologic data that can be used to estimate the rate of water movement through the vadose zone. The subtasks and field activities that are associated with the geologic investigation at each waste management unit are summarized in Table 5-3. The geologic investigation activities are detailed in Section 5.3.

The majority of geologic data will be collected from borings from selected analog sites. This activity will produce information on the lateral extent, vertical extent, and surface geometry of aquitards in the vadose zone. These aquitards are significant because they may retard the downward movement of water and form zones of perched water that allow the lateral movement of contaminants. Physical samples collected during the boring activities will be used to characterize the hydraulic properties of various vadose zone media.

5.1.4 Surface Water Sediment Investigation (Task 4)

The primary goal of this task is to evaluate the impact of facility operations on surface water sediments on the 200-UP-2 Operable Unit. The scope of this evaluation is fairly limited because surface water only occurs in the 207-U Retention Basin and in the active portion of the 216-U-14 Ditch. The active portion of the ditch is not proposed for study as part of the LFI. Sampling will be designed to estimate contaminant concentrations in the bottom sediments of the basin. This is of particular importance because this site is used by waterfowl and other biota.

Table 5-4 summarizes the subtasks and field activities associated with the surface water sediment investigation at each waste management unit. The surface water sediment investigation activities are detailed in Section 5.3.

5.1.5 Vadose Zone Investigation (Task 5)

The primary objective of this task is to define the nature and vertical extent of contamination in the vadose zone. This includes characterizing contamination in vadose zone soils and in perched water. Data will also be collected to aid in modeling contaminant transport through the vadose zone. The subtasks and field activities associated with the vadose zone investigation are summarized in Table 5-5. The majority of vadose zone data will be collected during boring and subsurface geophysical field activities. The vadose zone activities are detailed in Section 5.3.

5.1.6 Air Investigation (Task 6)

The scope of this task is to evaluate worker safety during field activities, to establish background concentrations of airborne contaminants, and to monitor the impacts of field activities on area-wide air quality. The subtasks and field activities associated with the air investigation are summarized in Table 5-6. The majority of air-related data will be collected from an existing high volume sampling network, and from job-site health and safety monitoring equipment. The air investigation activities are detailed in Section 5.3.

5.1.7 Data Evaluation (Task 7)

Data generated during the LFI will be evaluated and integrated with existing data in an ongoing manner. Data from some field activities will be used to define later activities. The data evaluation task is described in detail in Section 5.4.

5.1.8 Qualitative Risk Assessment (Task 8)

Qualitative risk assessments are performed on waste management units that are eligible for IRMs. These assessments provide a semiquantitative assessment of risk, and are focused on the principal risk drivers in the operable unit. The results of these assessments are used to help determine the need for an IRM, to select the IRM, and to determine risk-based cleanup levels for the IRM. The qualitative risk assessment is discussed in detail in Section 5.5.

5.1.9 Identification of Potential Contaminant- and Location-Specific ARARs (Task 9)

The identification of potential operable unit-specific ARARs will be an ongoing effort during the LFI/IRM process and is described in more detail in Section 5.6.

5.1.10 LFI Report (Task 10)

An interim report will be prepared that presents the results of the LFI and qualitative risk assessment at each high priority waste management unit. Data from low priority units will also be incorporated into the report, although no attempts will be made to analyze these data. The LFI report is described in more detail in Section 5.7.

5.1.11 Other Tasks (Task 11)

This task has been reserved in the event that additional tasks are identified during the course of the project.

5.2 PROJECT MANAGEMENT (TASK 1)

Specific Project management activities that will occur throughout the LFI include:

- Subtask 1a, Project Management (Section 5.2.1)
- Subtask 1b, Meetings (Section 5.2.2)
- Subtask 1c, Cost and Schedule Control (Section 5.2.3)

- Subtask 1d, Data Management (Section 5.2.4)
- Subtask 1e, Progress Reports (Section 5.2.5)
- Subtask 1f, Quality Assurance (Section 5.2.6)
- Subtask 1g, Health and Safety (Section 5.2.7)
- Subtask 1h, Community Relations (Section 5.2.8).

5.2.1 Project Management (Subtask 1a)

Project management includes the day-to-day supervision of, and communication with, project staff and subcontractors. Throughout the project, daily communication between office and field personnel will be attempted, along with periodic communication with subcontractors. This constant and continual exchange of information will be necessary to assess progress, to identify potential problems quickly enough to make necessary corrections, and to keep the project within the budget and focused on the objectives and schedule. Details of project management are presented in the PMP, an attachment to the U Plant Source AAMSR.

5.2.2 Meetings (Subtask 1b)

Meetings will be held, as necessary, with members of the project staff, subcontractors, regulatory agencies, and other appropriate groups to communicate information, assess project status, and resolve problems. A kickoff meeting will be held with designated project personnel, and project staff meetings will be held weekly. The 200-UP-2 Operable Unit project coordinators will meet on a weekly basis to share information and to discuss progress and problems. The frequency of other meetings will be determined based on need and on schedules in the Tri-Party Agreement (Ecology et al. 1990).

5.2.3 Cost and Schedule Control (Subtask 1c)

Project costs, including labor, other direct costs, and subcontractor expenses will be tracked monthly using an earned value approach. The budget for tracking activities will be computerized and will provide the basis for invoice preparation and review and for preparation of progress reports. Scheduled milestones will be tracked monthly for each task of each project phase. This will be done in conjunction with cost tracking.

5.2.4 Data Management (Subtask 1d)

The work activity file for the 200-UP-2 Operable Unit will be kept organized, secured, and accessible to project personnel. The project file will be maintained to comply with the Information Management Overview (IMO), which is included in the U Plant Source AAMSR. All field reports, field logs, health and safety documents, quality assurance/quality control (QA/QC) documents, laboratory data, memoranda, correspondence and reports will be logged into the file upon receipt or transmittal. This task is also the mechanism for ensuring that data management procedures are carried out as documented in the U Plant Source AAMSR IMO.

5.2.5 Progress Reports (Subtask 1e)

Progress reports prepared at quarterly intervals are believed to be sufficient for purposes of the LFI/FFS. The reports will be prepared, distributed to project personnel (project and unit managers, coordinators, contractors, subcontractors, etc.), and entered into the 200-UP-2 Operable Unit project file. The reports will summarize the work completed, present data generated, and provide evaluations of the data as they become available. Progress, anticipated problems, recommended solutions, upcoming activities, key personnel changes, status of deliverables, and budget and schedule information will be included in the reports.

5.2.6 Quality Assurance (Subtask 1f)

All work on the Hanford Site is subject to the requirements of DOE Order 5700.6C, *Quality Assurance* (DOE 1991a), which establishes broadly applicable QA program requirements for all types of project activities. To ensure that the objectives of this LFI are met in a manner consistent with the DOE Order, all work conducted by Westinghouse Hanford will be performed in compliance with existing QA manuals and the EET&P Function QAPjP that specifically describes the application of manual requirements to environmental investigations. The 200-UP-2 Operable Unit QAPjP (Attachment 1) details the QA/QC protocols to be followed during the 200-UP-2 Operable Unit RI/FS process. The QAPjP defines the specific means that will be used to ensure that the sampling and analytical data are defensible and will effectively support the purposes of the investigation.

5.2.7 Health and Safety (Subtask 1g)

The Health and Safety Plan (HSP) (U Plant Source AAMSR attachment) will be used to implement standard health and safety procedures for Westinghouse Hanford employees and contractors engaged in LFI/FFS activities in the 200-UP-2 Operable Unit.

Activities associated with field sampling and sample transport may involve both external and internal exposure to ionizing radiation from adjacent tanks, piping, and contaminated soils. Sample collection activities may also involve exposure to hazardous chemicals. Review by Westinghouse Hanford Occupational Health and Safety and issuance of any RWPs and HWOPs (EII 2.2, "Occupational Health Monitoring"[WHC 1991a]) will be performed prior to the start of any sampling activity. All personnel entering the job site will fulfill the minimum requirements for entry as discussed in EII 1.1., "Hazardous Waste Site Entry Requirements" (WHC 1991a).

An ALARA plan that addresses the potential radiation exposure of task personnel during field tasks will be completed prior to the commencement of field operations. Guidance on such assessments is found in WHC-CM-4-11 as referenced in EII 2.3, "Administration of Radiation Surveys to Support Environmental Characterization Work on the Hanford Site" (WHC 1991a). A Radiation Dose Assessment evaluation will be performed for the anticipated soil samples and upon its completion will be used in conjunction with estimates of sample size and duration of exposure to prepare an ALARA plan.

5.2.8 Community Relations (Subtask 1h)

Community relations activities will be conducted in accordance with the Community Relations Plan (CRP) for the Hanford Site (Ecology et al. 1989). All community relations activities associated with the 200-UP-2 Operable Unit will be conducted under this overall Hanford Site CRP.

5.3 FIELD ACTIVITIES (TASKS 2 TO 6)

This section describes the field activities to be performed for the LFI. The field activities are designed to accomplish the following tasks: source characterization (Task 2), geologic investigation (Task 3), surface water sediment investigation (Task 4), vadose zone investigation (Task 5), and air investigation (Task 6). These tasks are described in Section 5.1. Section 5.3 is intended to be a substitute for a normal field sampling plan, and each activity can be conducted with guidance from this section alone.

Table 5-7 summarizes the field activities that are planned at each waste management unit and unplanned release site. Several activities that are not associated with individual waste management units are listed on the table under their own headings. In addition, the table has been divided between primary field activities and supporting field activities. Supporting field activities must generally be conducted along with each of the primary field activities. The subsections of this work plan describing each field activity and waste management unit are also listed on the table.

Section 5.3.1 discusses the locations and frequencies of each activity, and is subdivided by waste management unit and unplanned release. The protocols and procedures for each type of field activity are described in Section 5.3.2. Section 5.3.3 describes the laboratory analyses that each sample will undergo.

5.3.1 Sampling Locations and Frequencies

The sampling locations and frequencies of many of the later activities are contingent upon the results of the initial activities. The general order of activities at each waste management unit will be:

(1) Surface radiation surveys

(2) Subsurface spectral geophysics on appropriate existing wells

(3) Soil gas surveys

(4) Electromagnetic (EM) surveys

(5) Ground penetrating radar (GPR) surveys

(6) Surface soil and surface water sediment sampling

(7) Test pits

(8) Borings with spectral geophysics as casing is telescoped

(9) Perched water sampling.

Surface radiation surveys are run for both health and safety reasons and to identify surface soil or sediment sampling locations. If no surface contamination is detected during the initial surface radiation or soil gas surveys, then no surface soil or sediment sampling will occur at that waste management unit. In some cases, this also means that no further field activities will occur at that waste management unit. Surface geophysics, surface radiation survey, and soil gas survey results will be used to locate subsurface soil sampling (boring) locations in cases where no engineering drawings are available for the facility.

The proposed field activities at each waste management unit are described below.

5.3.1.1 Tanks and Vaults. The 241-U-361 Settling Tank is the only 200-UP-2 tank that will be studied as part of the LFI program.

241-U-361 Settling Tank. A surface radiation survey will be run over and adjacent to the tank in conjunction with surveys of the 216-U-1 and 216-U-2 Cribs and the 2607-W-5 Septic Tank and Unplanned Release UN-200-W-19 (Figure 5-1). If surface contamination is detected in this surface stabilized area, up to five soil samples may be collected from the area covered by the unified survey. One of these five samples may be collected from the vicinity of the tank.

5.3.1.2 Cribs. Field activities are planned at the 216-U-1/216-U-2 and 216-U-8 Cribs. The 216-U-12, 216-U-16 and 216-U-17 Cribs are considered analogous to these facilities and will not undergo field investigations of their own (see Section 4.2.3). The 216-U-3 French Drain is also considered analogous to these cribs.

216-U-1 and 216-U-2 Cribs. A surface radiation survey will be run over and adjacent to the cribs. This survey will be run in conjunction with surveys of the 2607-W-5 Septic Tank and Drain Field, the 241-U-361 Settling Tank, and Unplanned Release UN-200-W-19 and will cover an area of approximately 7,500 m^2 (80,730 ft^2) (Figure 5-1). The entire area surrounding the cribs was interim stabilized in December 1991, so no surface contamination is expected. If surface contamination is detected, up to five soil samples may be collected from the area covered by the unified survey. Two of the five samples may be collected in the vicinity of the cribs. Nearby existing monitoring wells, 299-W19-3 and 299-W19-9, will undergo RLS gamma spectrometer surveys. Well 299-W19-11 has already undergone RLS gamma logging (Section 3.1). An inventory of the actual daily discharge to the 2607-W5 Drain Field will be made to help predict the likelihood of perched water formation.

One soil boring will be made through the 216-U-1 Crib (Figure 5-1). The crib has collapse potential so an evaluation must be completed to determine whether a special drilling platform will be required for the drill rig (Section 5.3.2.1). The boring will extend to the caliche layer (about 50 m, 160 ft). Figure 5-2 depicts a cross-sectional view of the boring and its relationship to the cribs. Figure 5-3 is a schematic diagram of the boring showing the sample locations for the chemical, physical, and archive samples.

The sampling protocol for the boring through the 216-U-1 Crib will be:

- Chemical Samples—Collect one sample from 4.6 m (15 ft) below the surface, immediately above the open crib structure. Measuring from the base of the open crib structure (approximately 6 m, 20 ft deep) collect chemical samples beginning at the following depths: 0, 0.6, 1.2, 3, 4.6, 6, 8, 9, 12, 18, 24, 30, 37, and 43 m (0, 2, 4, 10, 15, 20, 25, 30, 40, 60, 80, 100, 120, 140, and 160 ft). The actual number of samples sent for analysis may be reduced based on field screening results (Section 5.3.2.3).

- Physical Samples—Physical samples will be collected beginning at the following depths from below the base of the crib: 4, 7, 10, 13, 19, 25, 31, 37, and 43 m (12, 22, 32, 42, 62, 82, 102, 122, and 142 ft). Additional samples may be collected at major changes of stratigraphy or water content. A portion of each nonradioactive sample will be archived.

A second boring will be located midway between the 216-U-1/216-U-2, and 216-U-16 Cribs (Plate 1). This boring is placed here to characterize the extent of remobilization of 216-U-1/216-U-2 contaminants by 216-U-16 wastewater. This boring will extend to the caliche layer (about 50 m, 160 ft). Figure 5-3 is a schematic diagram of this boring showing the location of chemical, physical, and archive samples.

The sampling protocol for the boring between the three cribs will be:

- Chemical Samples—Collect samples beginning at the following depths below the surface: 4.6, 9, 14, 18, 23, 27, 32, 37, 43, and 49 m (15, 30, 45, 60, 75, 90, 105, 120, 140, and 160 ft). Each sample will undergo immediate field screening (Section 5.3.2.3). If it does not exceed contaminant action levels, it will not be sent to the lab for further analysis.

- Physical Samples—Collect samples beginning at the following depths below the surface: 5, 10, 14, 19, 23, 28, 33, 37, 43, and 49 m (17, 32, 47, 62, 77, 92, 107, 122, 142, and 162 ft). Additional samples may be collected at major changes of stratigraphy or water content. A portion of each nonradioactive sample will be archived.

A third boring will be placed north of the 216-U-1 and 216-U-2 Cribs, adjacent to the 2607-W-5 Septic Tank and Drain Field. This boring is shown on Figure 5-1. This boring will help characterize the northern extent of contamination from the cribs and determine if perched water zones are forming beneath the active 2607-W-5 Drain Field. The boring will extend to the caliche layer (about 50 m, 165 ft). Figure 5-3 is a schematic diagram of this boring showing the location of chemical and physical samples.

The sampling protocol for this boring will be:

- Chemical Samples—Collect samples beginning from the following depths below the surface: 2, 3, 5, 9, 15, 20, 30, 40, and 49 m (5, 10, 20, 30, 50, 70, 100, 130, and 160 ft). Each sample will undergo immediate field screening if it does not exceed contaminant action levels (Section 5.3.2.3), then it will not be sent to the lab for further analysis.

- Physical Samples—Collect samples beginning from the following depths below the surface: 3.5, 9.5, 16, 22, 31, 40, 49 m (12, 32, 52, 72, 102, 132, and 162 ft). Additional samples may be collected at major changes of stratigraphy or water content.

Both holes will undergo RLS spectral gamma logging.

216-U-8 Crib. A surface radiation survey will be run over the crib (approximately 75 x 75 m, 250 x 250 ft) (Figure 5-4). This area has not been surface stabilized so at least one and up to two surface soil samples may be collected from the most highly contaminated areas. The RLS gamma spectrometer surveys will be run at nearby existing wells 299-W19-69, 299-W19-70, 299-W19-71, and 299-W22-62.

One soil boring will be made through the middle open wood structure in the crib (Figure 5-4). The crib has collapse potential so an evaluation must be completed to determine whether a special drilling platform will be required for the drill rig. The boring will extend to the caliche layer (about 61 m, 200 ft). Figure 5-5 is a cross-sectional view of the boring and its relationship to the crib. Figure 5-6 is a schematic diagram of the boring showing the locations of chemical, physical, and archive samples. An RLS gamma spectrometer survey will be conducted as the boring is being made.

The sampling protocol for this boring will be:

- Chemical Samples—Collect one sample about 4.6 m (15 ft) below the surface, immediately above the open wood structure. Measuring from the base of the open crib structure (about 8.5 m, 28 ft) collect samples beginning at: 0, 0.6, 1, 3, 4.6, 6, 7.6, 9, 10, 20, 25, 30, 40, 43, and 50 m (0, 2, 4, 10, 15, 20, 25, 30, 40, 60, 80, 100, 120, 140, and 160 ft). The actual number of samples sent for analysis may be reduced based on field screening results (Section 5.3.2.3).

- Physical Samples—Collect samples beginning at the following intervals beneath the open crib structure: 4, 7, 10, 13, 19, 25, 31, 37, 43, and 49 m (12, 22, 32, 42, 62, 82, 102, 122, 142, and 162 ft). Additional samples may be collected at major changes of stratigraphy or water content. A portion of each nonradioactive sample will be archived.

5.3.1.3 Drains and Reverse Wells. Field activities are planned at the 216-U-4 Reverse Well/216-U-4A French Drain. The 216-U-4B and 216-U-7 French Drains are considered analogous to these units. The 216-U-3 French Drain is considered analogous to the cribs that were selected for study.

216-U-4 Reverse Well/216-U-4A French Drain. The 216-U-4 Reverse Well and the 216-U-4A French Drain are only 2.4 m (8 ft) apart and are being studied together. A surface radiation survey will be conducted over a 4.6 x 4.6 m (15 x 15 ft) area on the ground surrounding the two units (Figure 5-7). One surface soil sample will be collected from the most contaminated area or from between the two units if no radionuclide contamination is detected. A soil boring to the caliche layer (about 61 m, 200 ft) will be collared as close as possible to midway between the two units. Figure 5-8 is a schematic diagram showing the chemical, physical, and archive sample intervals in the boring.

The sampling protocol for this boring will be:

- Chemical Samples—Collect samples beginning at the following depths below the surface: 2, 3, 4.6, 7.6, 12, 20, 24, 26, 27, 30, 37, 43, 49, and 55 m (5, 10, 15, 25, 40, 60, 80, 85, 90, 100, 120, 140, 160, and 180 ft). The actual number of samples sent for analysis may be reduced based on field screening results (Section 5.3.2.3).

- Physical Samples—Collect samples beginning at the following depths below the surface: 4, 8, 13, 19, 25, 31, 37, 43, 49, and 55 m (12, 27, 42, 62, 82, 102, 122, 142, 162, and 182 ft). Additional samples may be collected at major changes of stratigraphy or water content. A portion of each nonradioactive sample will be archived.

5.3.1.4 Ponds, Ditches, and Trenches. A unified high priority confirmatory sampling program is planned for the 216-U-10 Pond and its associated ditches (216-U-11 Trench, 216-Z-1D Ditch, 216-Z-11 Ditch, and 216-Z-19 Ditch).

216-U-10 Pond System Confirmatory Sampling. A unified surface radiation survey will be run over the 216-U-10 Pond, the 216-U-11 Trench, the 216-U-14 Ditch, the 216-Z-1D Ditch, the 216-Z-11 Ditch and the 216-Z-19 Ditch (Figure 5-9). This survey will cover an approximate area of 372,000 m^2 (4,000,000 ft^2). If contamination is detected, up to ten surface soil samples may be collected from the most contaminated areas. This area has been surface stabilized, so if no radionuclide contamination is detected during the survey no samples need to be collected.

One test pit to an approximate depth of 11 m (35 ft) will be excavated in the center of the U Pond delta area (Figure 5-9). Chemical samples will be collected at the base of the clean fill cover (about 1 m, 3 ft) and at 1.5, 3, 6, and 11 m (5, 10, 20, and 35 ft). A physical sample representative of the material underlying the old pond will also be taken.

One test pit will also be dug through the center of the 216-U-10 Pond to an approximate depth of 11 m (35 ft). Chemical samples will be collected at the base of the clean fill (about 1.5 m, 5 ft), and at 3, 4.5, 7.5, and 11 m (10, 15, 25, and 35 ft). These depths are approximate, and the excavated material should be screened in the field so that the most contaminated samples are sampled. A physical sample representative of the material underlying the old pond (below 2 m) will also be taken.

5.3.1.5 Basins. The 207-U Retention Basin is the only basin within the 200-UP-2 Operable Unit. It will be studied in connection with the confirmatory sampling at the 216-U-10 Pond and its associated ditches.

207-U Retention Basin. A surface radiation survey will be conducted over the top of the basin and the surrounding area. This survey will cover a 61 x 101 m (200 x 330 ft) area (Figure 5-10). Up to two surface soil samples and two surface water sediment samples will be collected from the most highly contaminated areas. Surface geophysical surveys (GPR) will be conducted on the north and south sides of the basin to determine the locations of two 3-m (9.8 ft) deep waste disposal trenches. The GPR lines will be run parallel and 2, 3, and 6 m (5, 10, and 20 ft) from the north and south sides of the basin. Three perpendicular tie lines will also be run across the suspected trench locations.

The trench whose location is best defined by geophysics and the surface radiation survey will be partially re-excavated by a backhoe to a depth of 11 m (35 ft). Up to four samples will be collected from the backhoe excavation: one from within the old trench, one immediately below the trench bottom, and then at 10-foot intervals below that. These sample numbers and locations are approximate, and the excavated materials should be screened in the field so that only the most contaminated soils are sampled. A physical sample representative of material underlying the trench will also be collected.

5.3.1.6 Nonsite-Specific Activities. Nonsite-specific activities include a seismic reflection survey, perched water sampling, vadose zone model calibration investigations, air sampling, and a pipeline integrity assessment.

5.3.1.6.1 Seismic Reflection Survey. The seismic reflection survey will cover the entire 200-UP-2 Operable Unit. The exact location of the individual shot points has not yet been determined.

5.3.1.6.2 Perched Water Sampling. Five deep borings are planned for the 200-UP-2 Operable Unit investigation. If perched water is encountered in any of these borings then a perched water well will be installed against the water-bearing interval. The proposed locations of these borings are three at the 216-U-1/216-U-2 Cribs, and one at the 216-U-4 Reverse Well/216-U-4A French Drain and the 216-U-8 Crib. One perched water sample will be collected from each of these wells. In addition, four existing wells, 299-W-19-22, 299-W-19-91, 299-W-19-92, and 299-W-19-93 will be sampled if they are found to contain perched water. The locations of the existing wells and the new borings are shown on Plate 1.

5.3.1.6.3 Vadose Zone Model Calibration Investigations. Samples will be collected from one borehole to aid in the vadose zone contaminant migration modeling effort. The borehole should be one where contamination is considered unlikely so that the physical sample analyses are not complicated by health and safety concerns. The proposed location of this boring is about 180 m (590 ft) south of the southwest corner of the 211-U Building (Plate 1) Figure 5-11 is a schematic diagram of the boring showing the sampling intervals for physical samples. If a suitable boring is planned for the local groundwater investigation it may be selected for this study in the future.

5.3.1.6.4 Air Sampling. There are four high-volume air samplers stationed within the 200-UP-2 Operable Unit (Plate 1). The samplers contain filters, which collect particles entrained in the air. The sample filters are exchanged weekly and saved to be analyzed quarterly. The air sampling effort is an ongoing activity which is independent of the other activities described in this work plan. However, during the field work at the 200-UP-2 Operable Unit the air sampling results will be monitored more closely to see if the other field activities are impacting air quality. This monitoring will involve reviewing the data that are being generated by the ongoing program in order to see if field operations have in any way impacted the local air quality.

5.3.1.6.5 Process Effluent Pipeline Integrity Assessment. The process effluent pipelines indicated on Figure 5-12 will be tested for leaks. The total length of pipeline to be surveyed is approximately 700 m (2,300 ft). These are inactive process lines that run beneath the ground from the 222-U and 224-U Buildings to the analog units selected for study (Figure 5-12). Surface radiation surveys will be run over each of the process lines. Each line will also undergo an internal camera survey to identify major leak points. Up to six surface soil samples will be collected from the most contaminated areas identified over the pipelines. Test pits will be excavated over the most significant leak points identified by these two surveys. One test pit will be excavated along a section of vitrified clay pipe where there is no evidence of leaking. The vitrified clay pipes are relatively porous, and this test pit will provide a "background" value for contamination that occurs everywhere beneath these types of pipes.

Each test pit will be excavated to a depth of approximately 9 m (30 ft) and either one or two soil samples may be collected from the most contaminated intervals identified within the test pits. It is estimated that 6 surface soil samples and 3 test pits will be required to complete the integrity assessment.

5.3.1.6.6 216-U-12 pH Boring. A boring is planned immediately adjacent to the 216-U-12 Crib (Figure 5-13). The boring will extend to the caliche layer and samples will be collected at approximate 20 ft intervals (Figure 5-14). The samples will only be analyzed for pH and $CaCO_3$ content.

5.3.2 Protocols and Procedures

5.3.2.1 Surface Radiological Surveys. Surface radiological surveys will be conducted on several waste management units within the 200-UP-2 Operable Unit using low-level alpha, beta, and gamma (NaI) radiation detectors. Table 5-7 lists the individual units that will receive surface radiological surveys. Surveys will also be run as part of the pipeline integrity assessment task. Unified surveys should be run on units that are historically and geographically related to one another. These unit groupings include:

- The 216-U-1 and 216-U-2 Cribs, the 241-U-361 Settling Tank, the 2607-W-5 Tile Field, and Unplanned Release UN-200-W-19.
- The 216-U-10 Pond, the 216-U-11 Ditch, the 216-Z-1D Ditch, the 216-Z-11 Ditch, the 216-Z-19 Ditch, and the inactive portion of the 216-U-14 Ditch.

The approximate limits of each survey are shown on the individual maps of the waste management units (Figures 5-1 through 5-12). Survey boundaries will be extended until no further contamination is found along the survey boundaries. Surveys at the 216-U-1/216-U-2 and 216-U-8 Cribs will be conducted, in part, over areas with collapse potential. An engineering study on collapse potential is currently scheduled for fiscal year 1993 as part of the AARA program. The results of this study will be used to determine the radiation survey procedures for these cribs. Most of the surveys cover small areas and will be conducted with hand portable detectors. Surveys larger than 40,000 ft^2 will be conducted with the Ultrasonic Ranging and Data System (USRADS). The USRADS was selected because it automatically correlates and records count-rate, dose-rate, and position information during the survey. The surveys where USRADS will be used include: the unplanned releases associated with railroad lines, the unified survey over the 216-U-1/216-U-2 Cribs and surrounding units, the 207-U Retention Basin, the Burning Pit/Burial Ground, the 216-U-15 Trench, the 216-U-10 Pond System, and the surveys associated with the pipeline integrity assessment.

These surveys will be done primarily to locate areas of elevated radiation that will require surface sampling (Section 5.3.2.6). Samples will be collected from the most contaminated areas identified by the radiation survey. If two or more separate and distinct contaminated areas are identified during a given survey, then more than one sample may be collected. Samples should not be collected unless radionuclide contamination is indicated above action levels. The action level for radionuclide screening is twice background. Prior to the initial surveys, a one time instrument background will be determined at a background site to be determined in the field. Instrument background will be measured on a freshly disturbed surface soil, holding the instrument less than one inch from the soil.

Surveys will be conducted by a qualified health physics technician (HPT). This individual will be responsible for verifying the proper working condition of the instruments and for recording field measurements in accordance with the applicable health physics procedures (WHC 1991a) and EII 2.3, "Administration of Radiation Surveys to Support Environmental Characterization Work on Hanford Site" (WHC 1991a). A survey report will be prepared for each site. The report will include a description of the survey methods used, the survey results, and a list of surface soil sampling location recommendations.

5.3.2.2 Surface Geophysical Surveys. Surface EM, and GPR surveys are planned for the 207-U Retention Basin. An electromagnetic survey will use a transmitter coil to induce eddy currents in the subsurface. The eddy currents generate a secondary electromagnetic field which is measured with a receiver coil. The intensity of these currents is a function of ground conductivity. The EM survey will be used to detect buried metallic objects and delineate the limits of disturbed ground, contaminant plumes, and saturated layers. A GPR survey will generate a continuous profile of shallow subsurface features by transmitting and then receiving reflected high frequency radio waves. The GPR will also be used to detect buried objects and voids, and to delineate the limits of disturbed ground. Used in conjunction, these techniques yield mutually supporting evidence that may be used to define trench boundaries and buried object locations with a high degree of certainty.

These surveys will be done before the test pit is made at the Retention basin because they are nonintrusive and can be used to locate disturbed ground boundaries, buried objects, and backfill depths. This information will be used to help find the trench boundaries. Specific survey grid coordinates will be established from a minimum of three recoverable reference points, staked and located during a later geodetic survey. Each data point will be designated with a unique number associated with the facility and its grid location. All geophysical surveys will be conducted according to EII 11.2, "Geophysical Survey Work" (WHC 1991a).

5.3.2.3 Source Area Borings. Five deep borings will be made during the 200-UP-2 Operable Unit field investigations (Table 5-7). Additional shallow borings may be required if conditions prevent test pits to be excavated at one of the proposed sites or if a test pit reaches its maximum depth and still is in contaminated material (Section 5.3.2.5). Each deep boring will extend to the caliche layer, which is generally between 46 and 60 m (150 and 200 ft) deep. If perched water is encountered in the boring, a well will be installed that is screened against the water-bearing interval.

Drilling. The borings will be sited to avoid buried obstructions and to target areas that appear most contaminated. Before drilling commences, an onsite and offsite utility check should be performed and the area checked with a pipe and cable locator. In all cases, drilling will also be preceded by a surface radiation survey of the area and at some locations (Table 5-1) surface geophysics and soil gas surveys. If a boring through a crib encounters contamination at such high levels that it cannot be continued as determined by health physics personnel, it should be abandoned and a new boring begun immediately outside the crib. Also, if a boring does not encounter a caliche layer or another significant aquitard at the same approximate depth, it will extend to the groundwater.

The drilling technique used on the boreholes will be the cable-tool method or one of other acceptable technologies. Drilling operations will be conducted according to EII 6.7, "Resource Protection Well and Test Borehole Drilling," (WHC 1991a) and EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment" (WHC 1991a). A short drive barrel or split-spoon sampler (0.6 m, 2 ft maximum length) will be used to remove soils (slough and/or pristine material) from the borehole between sampling intervals. Hard tool drilling will only be initiated as a last resort when drilling conditions are not conducive to the use of the drive barrel or split-spoon sampler. The decision to drill with the hard tool will be made by the drilling field team leader only after consultation with the well-site geologist and/or the project coordinator.

Temporary casing will be driven frequently to minimize the slough in the borehole. Casings will be telescoped through intervals of contamination to limit the driving of contaminants deeper into the vadose zone. The approximate casing sizes to be used will be 15, 20, and 25 cm (6, 8, and 10 in.) casings. The casings will be telescoped as contaminant concentrations decrease. The 25 cm (10 in.) casing will be run to at least 2 m (7 ft) below the crib or french drain and will be telescoped when grab samples from the boring are less than 5,000 ct/min according to field screening. The 20 cm (8 in.) casing will be used to control gross contamination from 500 to 5,000 ct/min. The 15 cm (6 in.) casing will be used to control gross contamination below 500 ct/min. For borings at which little or no contamination is expected, such as at the 2607-W-5 Septic Tank and Drain Field or at the boring between the 216-U-1/216-U-2 and 216-U-16 Cribs, only 15 and 20 cm (6 and 8 in.) casings need be used. For the shallow boring at the 216-U-10 Pond, only 15 cm (6 in.) casings will be used. Whenever the casing is telescoped, an RLS gamma spectrometer survey will be run on the hole. The survey procedures are outlined in Section 5.3.2.6.

As drilling proceeds, the well-site geologist will be responsible for completing the borehole geologic log. The borehole geologic log will be completed according to EII 9.1, "Geologic Logging" (WHC 1991a). The geologic log will contain sample type and depth, lithologic description, crib construction characteristics, and any other geologic information the well-site geologist believes is pertinent to the characterization of the subsurface stratigraphy. Each log sheet should contain no more than 3 m (10 ft) of stratigraphic information.

If perched water is encountered in a boring, a perched water well will be installed that is screened against the water-bearing interval. Each telescoped casing will be cut and left in place so that it extends about 1 m (3 ft) in the larger-diameter casing above. Any hole that does not encounter perched water will be abandoned. Holes will be abandoned according to the procedures outlined in EII 6.7, "Resource Protection Well and Test Borehole Drilling" (WHC 1991a).

Perched water wells will be installed after the boreholes have been advanced to the proper depth. The design and specification of these wells will be according to the information presented in "Generic Specifications - Groundwater Monitoring Wells" (WHC 1991b). In general, the wells will be constructed of 0.1 m (4 in.) inner diameter 304 stainless steel, joint-threaded casing, and wire-wrapped well screen. The screen slot and pack sand size will be determined from the results of sieve analyses. The wells will be installed according to procedures outlined in EII 6.8, "Well Completion" (WHC 1991a).

Sampling. Chemical, physical, and archive samples will be collected from each borehole. The split-spoon sampler will be the primary device for collecting these samples. Before the head and shoe are removed from the split-spoon sampler, drilling personnel are required to mark the sampler (with chalk or other suitable marking device) to ensure that the sampling personnel or geologist can distinguish the top and bottom of the sampler. All split-spoon sampling depths will be referenced to the maximum depth the split-spoon is driven. All depths will be recorded to the nearest 0.025 m (0.10 of a foot). The chemical, physical, and archive sampling intervals are unit- and depth-specific and are described along with the individual borings in Section 5.3.1. The sampling intervals are only approximate depths and may be modified at the discretion of the on-site geologist. If perched water is encountered in a boring the sampling interval should be modified such that at least one chemical and physical sample is collected in the saturated zone. Physical and chemical samples are generally grouped together so that the two sets of data may be compared. Chemical samples always take precedence over physical samples, which take precedence over archive samples. Sample intervals may be extended by driving the split-spoon sampler a second time if an insufficient sample is collected during the first attempt. It should be noted that some borings will require continuous sampling over part of their length to meet these sampling requirements. This is particularly true of the first 4.5 m (15 ft) drilled beneath each of the cribs.

Chemical samples will be collected in accordance with EII 5.2, "Soil and Sediment Sampling" (WHC 1991a). Chemical samples will be collected with a split-spoon sampler with stainless steel liners. Drilling personnel will not overdrive the sampling device. The split-spoon and liners will be decontaminated before use according to EII 5.5, "1706 KE Laboratory Decontamination of Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) Sampling Equipment" (WHC 1991a). Prior to sampling, slough in the borehole will be removed to the greatest extent possible. Sampling personnel will transfer samples from the split-spoon liners to the appropriate sample containers and preserve them in accordance with the EPA guidelines set forth in *Test Methods for Evaluating Solid Wastes* (EPA 1986a). All chemical samples will be geologically logged by the well-site geologist. Chemical samples will be labeled with the appropriate Hanford Environmental Information System (HEIS) number to accommodate sample tracking and data entry into the HEIS system.

All samples and cuttings will be field screened for evidence of volatile organics and radionuclides. Volatiles will be screened by the field geologist or other qualified personnel using an organic vapor monitor. Radionuclides will be screened by alpha and gamma counting instruments. All instruments will be used, maintained, and calibrated consistent with EII 3.2, "Health and Safety Monitoring Instruments" (WHC 1991a), and EII 3.4, "Field Screening" (WHC 1991a). Radionuclides will be screened according to EII 3.4, "Field Screening" (WHC 1991a). The field geologist will record screening results in the borehole log (EII 9.1, "Geologic Logging" [WHC 1991a]). For two of the proposed borings (at the 2607-W-5 Septic Tank and Drain Field, and at the boring between the 216-U-1/216-U-2 and 216-U-16 Cribs), the decision to analyze a chemical sample from one of the designated intervals is dependent upon the results of the field screening. If a sample from either of these two borings does not contain radionuclide or volatile organic contamination above the set action levels, it should not be sent for analysis.

For the other three borings, the number of chemical samples that are sent to the lab may also be reduced by field screening. If two or more chemical samples in a row are found to be below action levels, then only every second sample will be sent to the lab for analysis. If later field screening identifies contamination deeper in the boring, then material from every designated sampling interval will be sent to the lab until two or more chemical samples in a row are below action levels.

The action level for radionuclide screening is twice background. The action level for volatile organic screening is 5 ppm above background. Prior to initiating drilling, determine a one-time instrument background reading using the above instruments at a background site to be determined in the field. Instrument background will be measured on freshly disturbed surface soil, holding the instruments less than 2 cm (1 in.) from the soil. The field geologist will record the background levels in the borehole log according to EII 9.1, "Geologic Logging" (WHC 1991a), prior to the start of drilling.

Physical samples will be collected by the same procedures as for chemical samples. Most of the physical samples will undergo a limited set of physical analyses (Type A samples), but two samples from each borehole will undergo a much larger set of physical analyses (Type B samples). Both suites of physical analyses are described in Section 5.3.3. The samples to undergo the additional analyses will be selected by the field geologist on site. Portions of physical samples that have been unconditionally radiologically released will be sent to an existing storage facility to be archived. Contaminated samples will be sent to a long-term storage facility if one is available. If one is not available, such samples will not be collected. The nonradioactive samples will be archived according to EII 5.7A, "Hanford Geotechnical Sample Library Control" (WHC 1992a).

The samples must be collected and transported in a manner that preserves the original moisture content and soil structure. Type A samples will be collected in a seamless polished aluminum "moisture tin" and in one stainless steel sample sleeve. The sample in the sleeve must be in an undisturbed state and the sleeve must be as full as possible. Type B samples will be collected in two undisturbed sample sleeves and in two moisture tins.

5.3.2.4 Backhoe Test Pits. Backhoe test pits are planned at the 216-U-10 Pond and the 207-U Retention Basin. A similar trenching effort has already taken place at the 316-5 Process Trenches (DOE 1991b). The maximum depth that can be reached by trenching is about 12 m (39 ft).

The excavation field work will be conducted using a crawler-mounted backhoe on a full revolving base or other appropriate equipment. The excavations will be done at the center of the waste management units to the necessary depth. None of the waste management units that are assigned excavations have collapse potential; therefore, the backhoe may be positioned as close as necessary to each unit.

Sampling areas will be designated at least 9 m (30 ft) away from the excavation pit within reach of the bucket. Samples will be collected from the backhoe bucket using hand tools and standard soil sampling techniques identified in EII 5.2, "Soil and Sediment Sampling" (WHC 1991a). Samples will be logged by a geologist. After the test pit has been completed, it will be backfilled with the excavated material. This action will require regulator approval. Such approval has been granted at other Hanford study areas in the past.

5.3.2.5 Subsurface Geophysics. Subsurface geophysics will be run on the new boreholes as each casing string reaches its maximum depth. Boreholes will be logged according to EII 11.1, "Geophysical Survey Work" (WHC 1991a). A description of the typical equipment configuration, calibration, and acquisition parameters for this technique is presented in Appendix A. Spectral gamma logs will also be done on eight existing monitoring wells:

- 299-W19-3
- 299-W19-9
- 299-W19-11
- 299-W19-69
- 299-W19-70
- 299-W19-71
- 299-W22-62
- 299-W22-75.

These wells were selected for logging because they are located within or adjacent to waste management units that will undergo LFIs, and because recent gross gamma logging suggest that they intersect radionuclide contaminated intervals.

The RLS spectral gamma logs will be run on each new hole to provide an in situ spectral analysis. Gamma-gamma and neutron-epithermal-neutron logs will also be run if the technology is available at the time of the field work. These two techniques can give valuable information on the stratigraphy and water content of the units adjacent to the borehole.

Spectral gamma logging will be conducted during spring 1992 at Wells 299-W19-9, 299-W19-11, 299-W19-70, and 299-W22-75 as part of the 200 Area AAMSR screening study (WHC 1991b). Logging should be conducted at the other wells in the future.

5.3.2.6 Surface Soil Sampling. Surface soil samples may be collected at the waste management units indicated on Table 5-7. The actual number and locations of samples that will be collected at each waste management unit will depend upon the surface radiation survey results. Samples will be collected from the most contaminated areas identified by the radiation surveys. If two or more separate and distinct contaminated areas are identified during a given survey then more than one sample may be collected. At waste management units that have been surface stabilized samples should not be collected unless radionuclide contamination is indicated above action levels by surface radiation surveys. At waste management units that have not been surface stabilized, at least one sample should be collected even if the surface radiation survey does not identify any contamination. Such a sample should be collected at the approximate center of the unit. If contamination is detected, the determination of the sampling locations should be made during the surface radiation surveys and is described in more detail in Section 5.3.2.1.

Samples will be collected with a stainless-steel shovel. Surface soil samples will be collected according to EII 5.2, "Soil and Sediment Sampling" (WHC 1991a). The analyses that each sample will undergo are further described in Section 5.3.3. Each sample will be sent to the appropriate controlled facility for classifications before being sent to a laboratory for analysis.

5.3.2.7 Surface Water Sediment Sampling. The exact locations will be based on results of the surface radiological survey data and site observations that are made. Details on the sediment sampling and handling are provided in EII 5.2, "Soil and Sediment Sampling" (WHC 1991a). Samples will be screened for radiation in the field. If radiation is present at levels above what has been determined to be background for the unit, the samples will be sent to the appropriate controlled facility for classifications before being sent to a laboratory for analysis.

5.3.2.8 Perched Water Sampling. Perched water samples will be collected from up to nine wells: five from new wells (if perched water is encountered), and four from existing wells (where perched water has been observed in the past). No other existing wells in the area are screened against potential perched water zones and have been noted to contain perched water (Section 5.3.1.6.2). The actual number may be less depending upon how many of these wells are found to contain perched water. Perched water sampling will be conducted according to the protocols listed in EII 5.8, "Groundwater Sampling" (WHC 1991a). Temperature, pH, turbidity, and electrical conductivity will be monitored during the purging of each well. Wells will be purged until a minimum of three well and sand pack pore space volumes have been removed, all parameters have stabilized, or the well is dry. Purged groundwater will be collected and properly disposed of depending upon its quality as described in EII 10.3 "Purgewater Management" (WHC 1991a). For all analyses expect for volatile organics, tributyl phosphate and kerosene, two samples will be collected per well instead of one; one will be unfiltered, and a second will be filtered through a 0.45 micron filter onsite before being bottled and preserved. Only an unfiltered sample will be required for organic analyses. Samples will be labeled with the well designation, an indication of the filtration, and the date of collection.

Water level measurements will be taken monthly and before the wells are purged and sampled. These data will be used to evaluate water level fluctuations and to establish horizontal and vertical groundwater gradients. These data will also be used to determine the amount of water that needs to purged from each well before it is sampled. All measurements will be conducted according to EII 10.2, "Measurement of Groundwater Levels" (WHC 1991a).

5.3.2.9 Vadose Zone Model Calibration Investigations. A special boring will be made near the approximate center of the operable unit to collect data for vadose zone model calibration. If an appropriate groundwater well boring is planned in the near future this activity may be conducted in conjunction with the groundwater well installation. Physical samples will be collected every 3 m (10 ft) from the boring. For every third sample (about every 9 m, 33 ft), or whenever there is a change in formation or a significant change in lithology, a sample will be collected for more detailed physical analysis (Figure 5-11). The two different levels of physical analyses are described in Section 5.3.3. The sampling protocols and procedures will be the same as those detailed for borehole physical samples in Section 5.3.2.4, Source Area Borings.

5.3.2.10 Air Sampling. There are four air sampling locations. The air samples are collected by drawing ambient air through a 47-mm, open-face filter at about 1 m above the ground (2 ft^3/min flowrate) using high-volume air samplers. Throughout the 200 Areas, air samplers are operated on a continuous basis. Sample filters are exchanged weekly, held one week to allow for decay of short-lived natural radioactivity, and sent for initial laboratory analyses of gross alpha and beta activity. After the initial analysis, the filters are stored until the end of the calendar quarter, at which time they are composited by sample location (or deemed as appropriate according to the annual reports) and sent for laboratory analyses of specific radionuclides. Compositing of the filters by sample location provides a larger sample size, and thus a more accurate measurement of the concentration of airborne radionuclides resulting from operations in the 200 Areas.

5.3.2.11 Pipeline Integrity Assessment. Approximately 700 m (2,300 ft) of pipelines will be surveyed as part of this activity (Figure 5-12). A surface radiation survey will first be run over and 7.6 m (25 ft) to either side of the pipelines. The width of the survey will be increased if contamination is noted on the survey boundaries. The surface radiation surveys will be conducted with USRADS. The radiation surveys will be conducted according to the protocols described in Section 5.3.2.1. Surface soil samples will be collected from the most contaminated zones that are centered over the pipelines.

Camera surveys will also be made of each of the pipelines. The emphasis of these surveys will be to identify major leak points in the lines and to attempt to correlate them to the identified surface contamination.

Test pits will be excavated along the most significant leak points identified by the previous surveys. In addition, one test pit will be excavated along a section of vitrified clay pipe where there is no evidence of leaking. The test pits will be dug to a depth of approximately 30 ft and between one and three samples may be collected from each pit. The excavation and sampling procedures for the test pits are the same as those described in Section 5.3.2.4.

5.3.2.12 216-U-12pH Boring. This boring will be conducted according to the protocols and procedures outlined in Section 5.3.2.4, Source Area Borings. The boring will extend to the caliche layer [about 55 m (180 ft)]. Samples will be collected every 6 m (20 ft) or at significant changes in lithology or $CaCO_3$ content. In addition, the geologist will field check samples every 1.5 m (5 ft) with dilute HCL in order to qualitatively log the $CaCO_3$ content of the soil. The laboratory samples will only be analyzed for pH and $CaCO_3$ content.

5.3.2.13 Sample Designation and Handling. Field logs will be maintained to record all field observations and activities according to EII 1.5, "Field Logbooks" (WHC 1991a). Samples for laboratory analysis will be taken at 11 waste management units and along two pipelines within the 200-UP-2 Operable Unit as indicated in Tables 5-7 and 5-8. These will be placed in containers and properly preserved. All samples for laboratory analysis will be transported under chain of custody in accordance with EII 5.1, "Chain of Custody" (WHC 1991a), and EII 5.11, "Sample Packaging and Shipping" (WHC 1991a). Laboratory analysis will be conducted on designated samples. The analysis of the soil and source samples will include determination of physical, chemical, and radiological characteristics.

The HEIS is used to track the sample and laboratory data obtained during these investigations. Each sample will be identified and labeled with a unique HEIS sample number. The HEIS numbers will be assigned in the field according to EII 5.10, "Obtaining Sample Identification Numbers and Assessing HEIS Data" (WHC 1991a). The sample location and corresponding HEIS numbers will be documented in the field logbook.

5.3.2.14 Decontamination Equipment and Procedures. Equipment decontamination will occur in conjunction with most of the sampling activities planned at the 200-UP-2 Operable Unit. The methods will generally consist of washing or steam cleaning with a detergent/water or other decontamination solution. Rinsing with a diluted nitric acid solution may be necessary to remove metal oxides and hydroxides. Field decontamination of drilling equipment, where applicable, shall be performed within impoundments in the decontamination zone to ensure that all wash liquids are captured. All wash liquids used for decontamination purposes must be properly disposed of according to applicable state/federal regulations. Drilling and backhoe equipment will be decontaminated before use on another borehole as required to ensure the safety of personnel and prevent cross-contamination of samples.

Decontamination procedures have been established for the Hanford Site by Westinghouse Hanford and are provided in the *Environmental Investigations and Site Characterization Manual* which includes decontamination requirements and specific methods for radiological and nonradiological contamination. The EII 5.4, "Field Decontamination of Drill, Well Development and Sampling Equipment" (WHC 1991a), establishes methods and equipment for decontaminating drilling equipment to mitigate cross contamination during drilling and samples collected for physical analysis only. The EII 5.5, "1706 KE Laboratory Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1991a), establishes methods and equipment for decontaminating sampling equipment that is used for both physical and analytical testing.

5.3.2.15 Investigation Derived Waste. Investigation derived waste (IDW) generated by LFI/FFS activities will be managed according to EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (WHC 1991a), or as agreed upon by the cognizant regulators (EPA, Ecology, DOE). If IDW is managed according to EII 4.3, the following exception to the procedure applies: Because of excessive turnaround times between sample submittal to the labs and receipt of sample analysis, if the 90 day clock (waste generation to disposal) is determined by the cognizant regulators to be appropriate for the RI/FS, the clock will not begin until generator receipt of the sample analyses results used for waste designation purposes. The samples collected for the LFI study will be sufficient for waste designation and waste management unit characterization.

5.3.2.16 Geodetic Surveys. Surveying applies to almost all the tasks required to complete the operable unit characterization and will occur at most of the waste management units within the operable unit (see Table 5-7). Surveys are to be completed by a licensed surveyor, registered in Washington State. Surveyors will be accompanied, at least initially, by the Field Team Leader (or designee) to familiarize the surveyors with specific locations. At least two vertical controls will be referenced to a U.S. Geological Survey datum obtained from a permanent bench mark. The NAD83 datum (Lambert Projection) will be used for horizontal control and the NGVD 1929 datum will be used for vertical control.

Horizontal (x,y coordinates) locations of surface soil samples; surface water sediment samples; and the corners of surface geophysical, surface radiation, and soil gas survey grids will be professionally surveyed. Horizontal and vertical locations (x, y, z coordinates) will be professionally surveyed for those soil borings that have a well screen installed. Abandoned borings and test pits will also be surveyed.

5.3.3 Laboratory Analysis

Surface soil samples, vadose zone soil samples (from borings and test pits), sediment samples, and perched water samples will be sent for chemical analysis. Air monitoring samples collected from the high volume samplers are controlled under a separate program and are typically analyzed for Co-90; Sr-137; Pu-238, 239, 240; U; gross alpha; and gross beta. Only vadose zone soil samples will be sent to the laboratory for physical analyses. Table 5-8 summarizes the types of samples that will be collected from each of the waste management units. The table also lists the general chemical and physical analyses that will be required. These analyses are described in greater detail in Sections 5.3.3.1 and 5.3.3.2.

5.3.3.1 Chemical Analyses. Table 5-9 lists the target analytes for the 200-UP-2 Operable Unit and specifies the suggested method of analysis. For some of the analytes, the contract lab may have to use a different analytical method than the suggested one. If an insufficient sample exists to perform all of the analyses, the analyses should be prioritized in the order they are listed on the table (Table 5-9, footnotes b,e). The concentrations of many of the radionuclide contaminants of concern (Table 3-2) will be calculated from parent or daughter relationships. The radionuclides whose concentrations will be calculated in this way are listed on the bottom of Table 5-9 (footnote a).

For the reasons listed below, the list of target analytes may be modified for some samples.

(1) Surface soil samples will not be analyzed for volatile organics. These compounds are unlikely to persist in near-surface conditions.

(2) Perched water samples will be analyzed for three additional analytes: fluoride, Carbon-14 and tritium. In addition, each water sample will undergo radionuclide and inorganic analyses on both filtered and unfiltered samples.

(3) Only two samples from each deep boring, and one sample from each test pit through the 216-U-10 Pond will be run for the full list of target analytes. The first samples collected beneath the assumed waste inflow point into the soil column of the samples that appear most contaminated by field screening, whichever is most appropriate, should undergo the full suite of analyses. The other samples from the boring or test pit should be saved until after the initial analytical results have been reviewed. Gamma

spectrometry will be run on all samples whatever the results from the first samples. However, for other analyses, only those analytes that had positive detections in the first samples will be analyzed for in the other samples from that boring or test pit.

Uranium isotopic analyses will only be made on the one or two samples from each boring or test pit that undergoes the full suite of target analyses (Table 5-9, footnote d). Whatever the results from these initial samples, the subsequent samples will not undergo uranium isotopic analyses because uranium concentrations will be calculated from Pa-234m concentrations (measured via gamma spectrometry). Uranium isotopic analyses will not be run on any surface soil or sediment samples for the same reason.

5.3.3.2 Physical Analyses. There are two suites of physical analyses. Type A physical analyses involve a limited suite of physical analyses and will be done on all samples from test pits and on most of the samples from deep borings. Type B physical samples involve additional physical analyses and will be done on two samples from each deep boring and approximately every third physical sample collected from the vadose zone model calibration boring. The samples will be analyzed using American Society for Testing and Materials (ASTM) methods.

The following physical analyses will be run on Type A samples:

- Bulk Density
- Particle Size Distribution
- Moisture Content
- $CaCO_3$ Content.

The following physical analyses will be run on Type B samples:

- The four Type A analyses listed above
- Saturated Hydraulic Conductivity
- Unsaturated Hydraulic Conductivity
- Matric Potential and Soil Moisture Retention Curves
- Particle Density

- Cation Exchange Capacity
- Organic Carbon Content
- pH and, if possible, Eh
- Mineralogy.

Samples from the pH boring at the 216-U-12 crib will undergo a very limited suite of analyses:

- pH
- $CaCO_3$ content.

5.4 DATA EVALUATION (TASK 7)

Data generated during the LFI will be integrated, evaluated, and coordinated with other IRM activities. The results of certain field activities will be evaluated immediately because they will influence the later LFI field activities. These include data from surface radiological, surface geophysics, soil gas, and pipeline camera surveys. Data from other LFI activities will undergo an initial review as it becomes available.. All information generated during the LFI will be integrated and evaluated for the LFI Report. An important part of this review will be the qualitative risk assessment. The results of these evaluations will be made available to project management personnel to keep them informed of the progress being made.

5.5 QUALITATIVE RISK ASSESSMENT (TASK 8)

A qualitative risk assessment is defined in the *Hanford Site Past-Practice Strategy* as "a judgment not based solely on quantification, agreed to by the parties, based upon available site data regarding the threat posed by site contamination" (DOE/RL 1992a). A qualitative risk assessment may be performed on the basis of existing site data, or may be performed following evaluation of LFI data, and is intended to support the justification and implementation of the IRM. The LFI premise is that it is not necessary, in all cases, to extensively characterize a site before cleanup decisions can be made. Qualitative risk assessments will be conducted in accordance with the guidance provided in the *Hanford Site Baseline Risk Assessment Methodology* (DOE/RL 1992b). Although qualitative assessments impose less stringent requirements for data quality, data collected during an LFI should possess the level of quality required by the quantitative baseline risk assessment. Qualitative risk assessments are currently planned for three groups of units, the 216-U-10 Pond system, the cribs, and the french drains and reverse wells.

In the case of the U Pond System, sufficient site and contaminant characterization data have been collected to enable identification of an IRM for that site. These data indicate vertical and horizontal distributions of key radiological contaminants of concern, and the appropriateness of an IRM.

One of the initial steps in proceeding with the IRM at U Pond will be performance of a qualitative risk assessment to better characterize the potential risks associated with the site and its known contaminants. The qualitative assessment will use existing contaminant data as input, with assumptions made as necessary to supplement these data and fill any significant data gaps. The assessment results, while not a final or definitive assessment of potential risks associated with the U Pond site, are a valuable tool in supporting the IRM and identifying risk-based target concentrations to guide IRM operations.

The qualitative risk assessment results will also be useful for judging the adequacy of existing data. Data gaps exist regarding the nature and extent of potential secondary contaminants. The need for further sampling and analyses that characterize potential secondary contaminants, primarily nonradioactive organic and inorganic compounds, will be evaluated in light of the qualitative risk assessment results. Additional characterization efforts may be determined to be unnecessary if the risk assessment results indicate that potential secondary contaminants are not likely to contribute to overall risks, or that primary contaminant concentrations are adequate predictors of secondary contaminant levels.

If additional characterization data are determined to be necessary, they will be collected and input to a qualitative reassessment of potential risks and target contaminant levels. Because the IRM will produce a wealth of data to refine the conceptual model, the qualitative risk assessment tools will remain available throughout the IRM process.

The qualitative risk assessment will implement the general methodology documented in *Hanford Site Baseline Risk Assessment Methodology* (DOE/RL 1992b). The commercial/ industrial exposure scenario will be adapted to the U Pond site, based on the specific physical characteristics of the site, and applicable transport pathways, exposure routes, and receptors will be defined.

5.6 IDENTIFICATION OF POTENTIAL CONTAMINANT- AND LOCATION-SPECIFIC ARARS (TASK 9)

The formulation of operable unit-specific ARARs is an ongoing process throughout the LFI/FFS. Potential ARARs were identified in the U Plant Source AAMSR and are summarized in Section 3.3. In addition, potential ARARs for the 200 West Area are being currently developed. Following the evaluation of analytical data under Task 7, potential contaminant-specific and location-specific ARARs will be reviewed based upon the new knowledge of contamination at the site and the site setting. Once the potential ARARs for the 200-UP-2 Operable Unit have been properly identified, EPA and Ecology will be asked to verify the potential contaminant- and location-specific ARARs.

5.7 LFI REPORT (TASK 10)

An interim report will be prepared upon completion of the limited field investigations. This report will consist of a preliminary summary of the characterization activities described in Tasks 1 through 9. Information pertinent to the operable unit conceptual model will be refined, as necessary. The report will include the results of source investigations, identify the nature and vertical extent of contamination at the high-priority liquid waste disposal facilities, identify the potential contaminant- and location-specific ARARs, and provide a qualitative assessment of the risks associated with the sites. The report will include an assessment of the need for IRMs at each site and will make recommendations on the IRM that should be implemented.

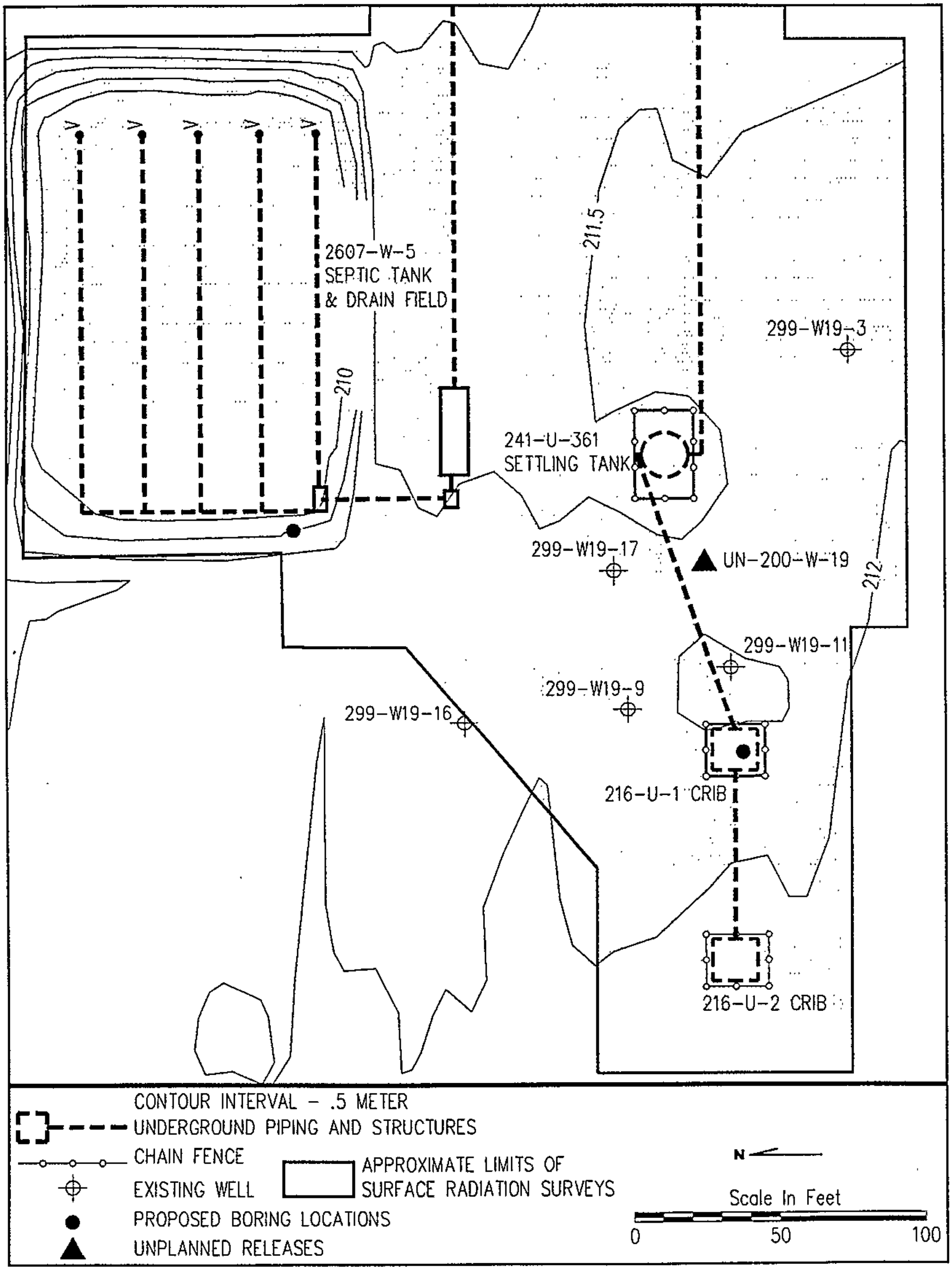
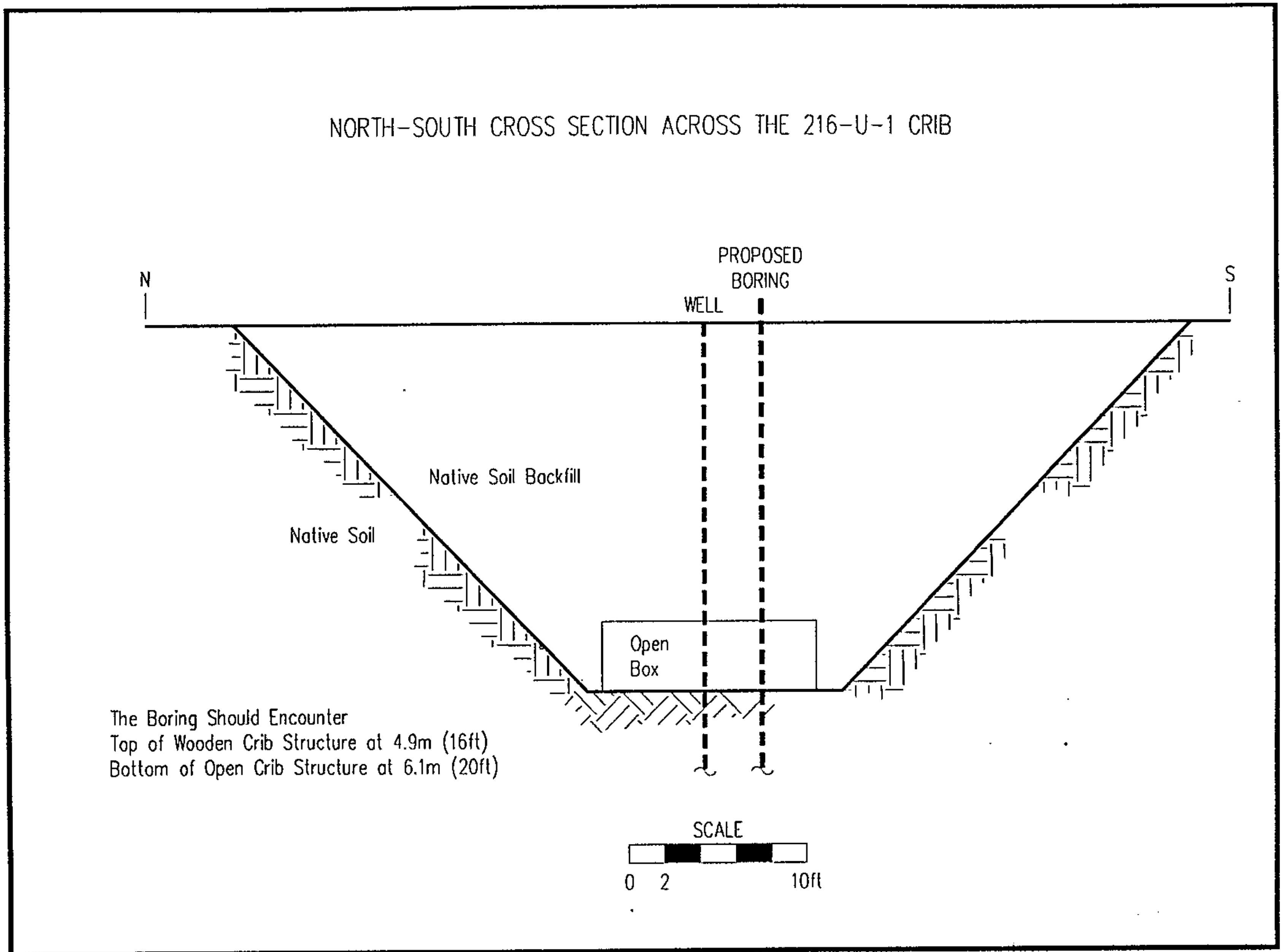


Figure 5-1. Map of the 216-U-1/216-U-2 Crib Area.

9 2 1 2 5 _ 1 3 1 9



200UP2-N

Figure 5-2. Cross Section of the 216-U-1 Crib.

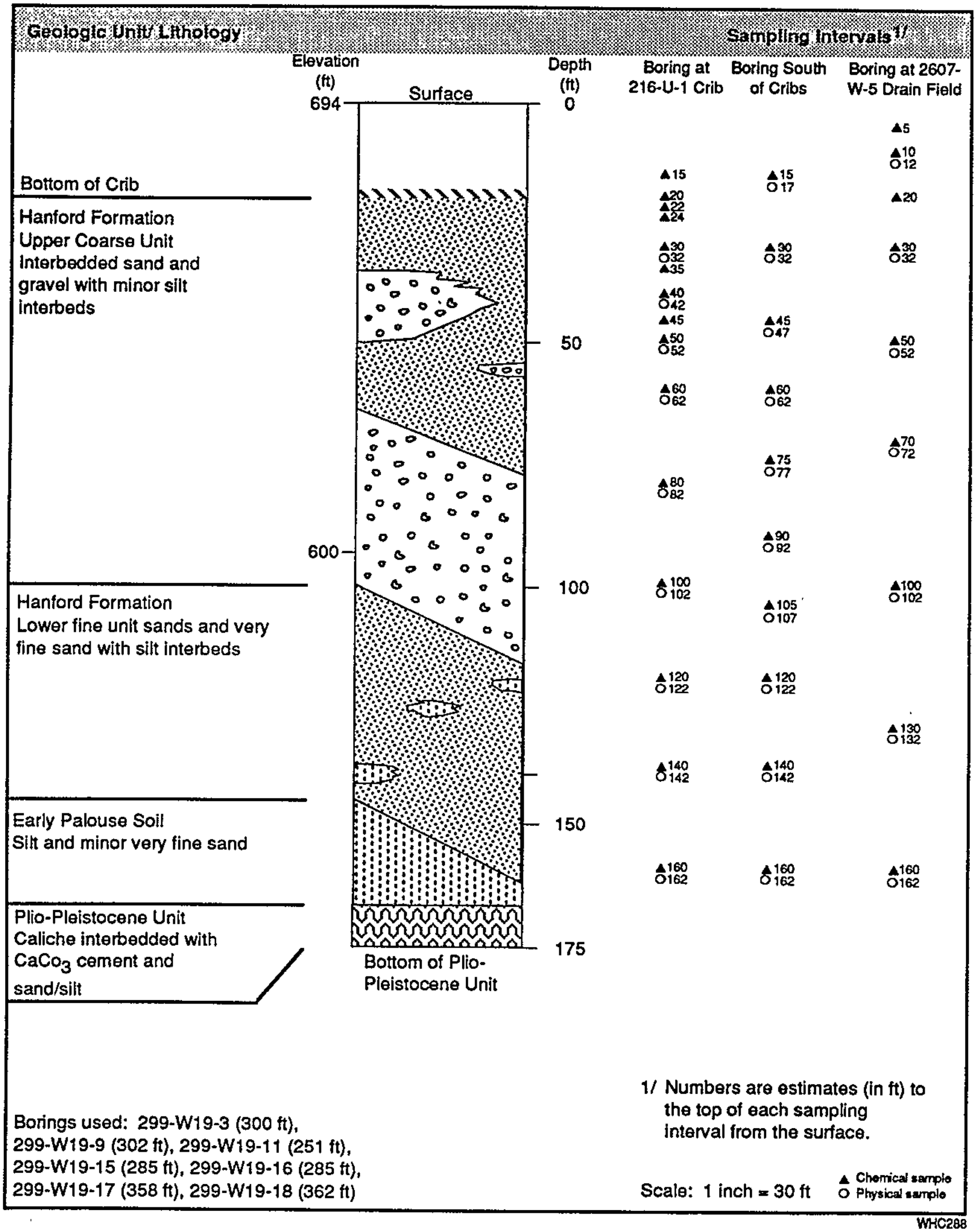


Figure 5-3. Sampling Intervals for Borings at the 216-U-1/216-U-2 Cribs and the 2607-W-5 Septic Tank.

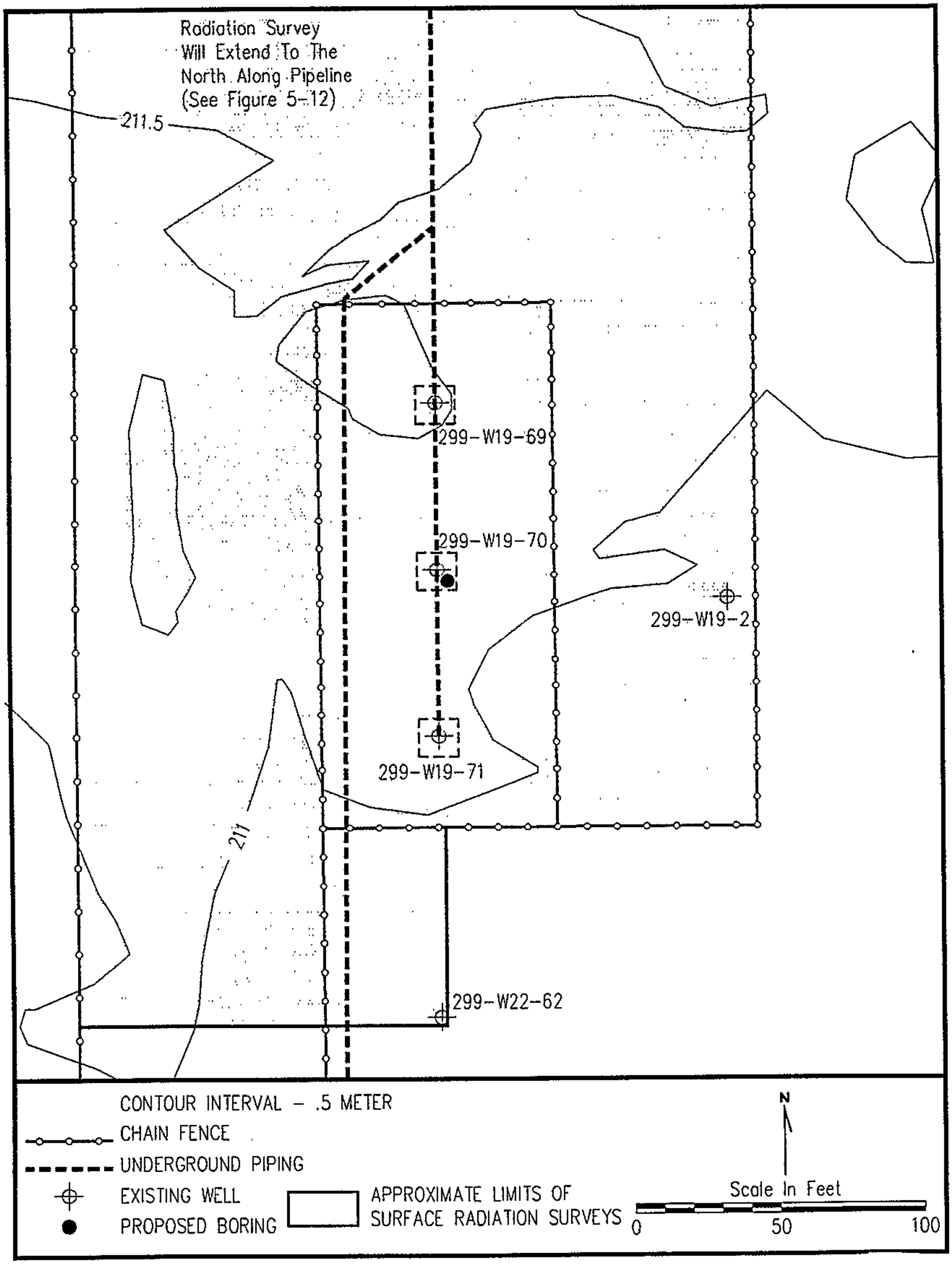
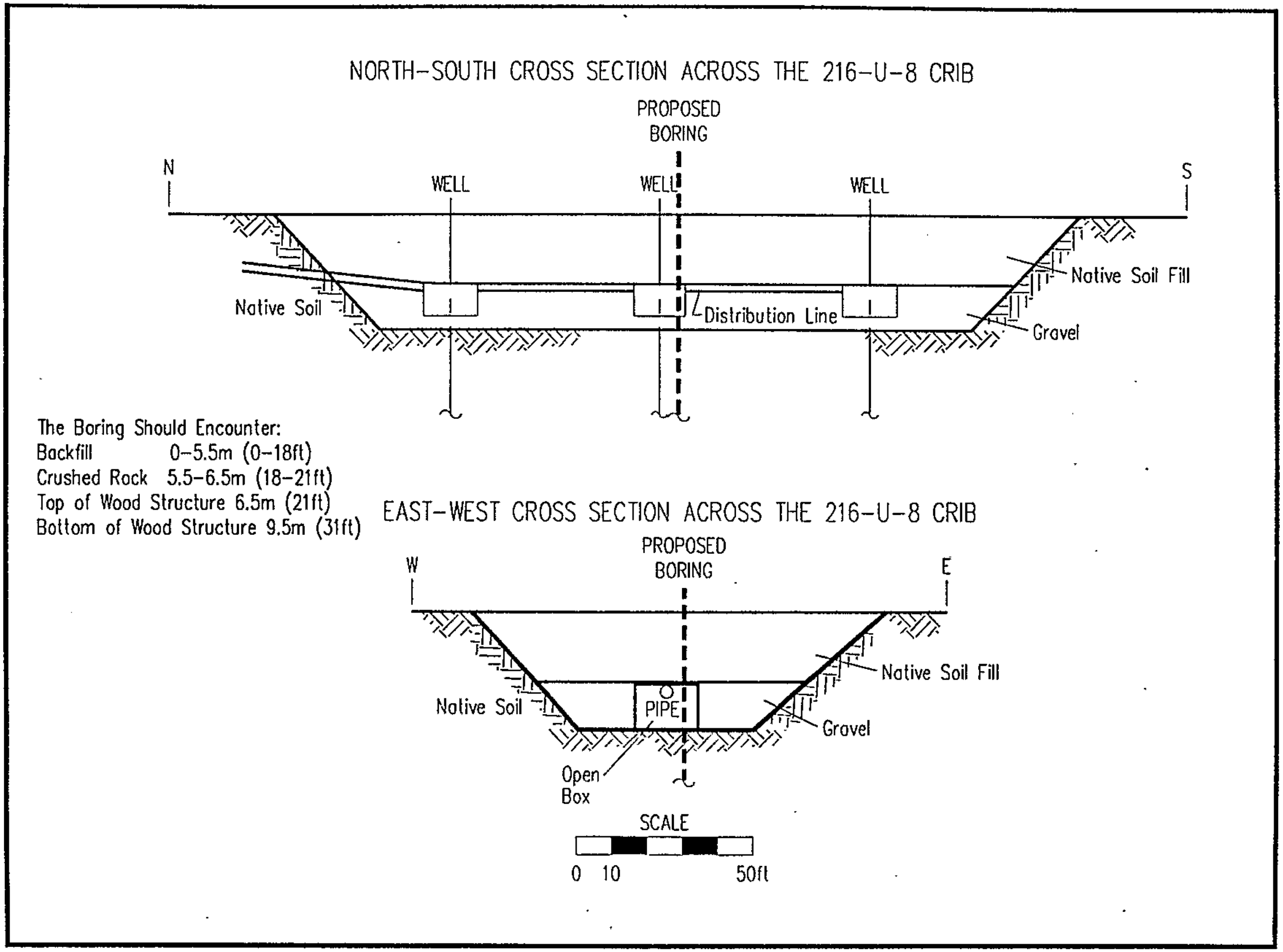


Figure 5-4. Map of the 216-U-8 Crib.



200UP2-L

Figure 5-5. Cross Sections of the 216-U-8 Crib.

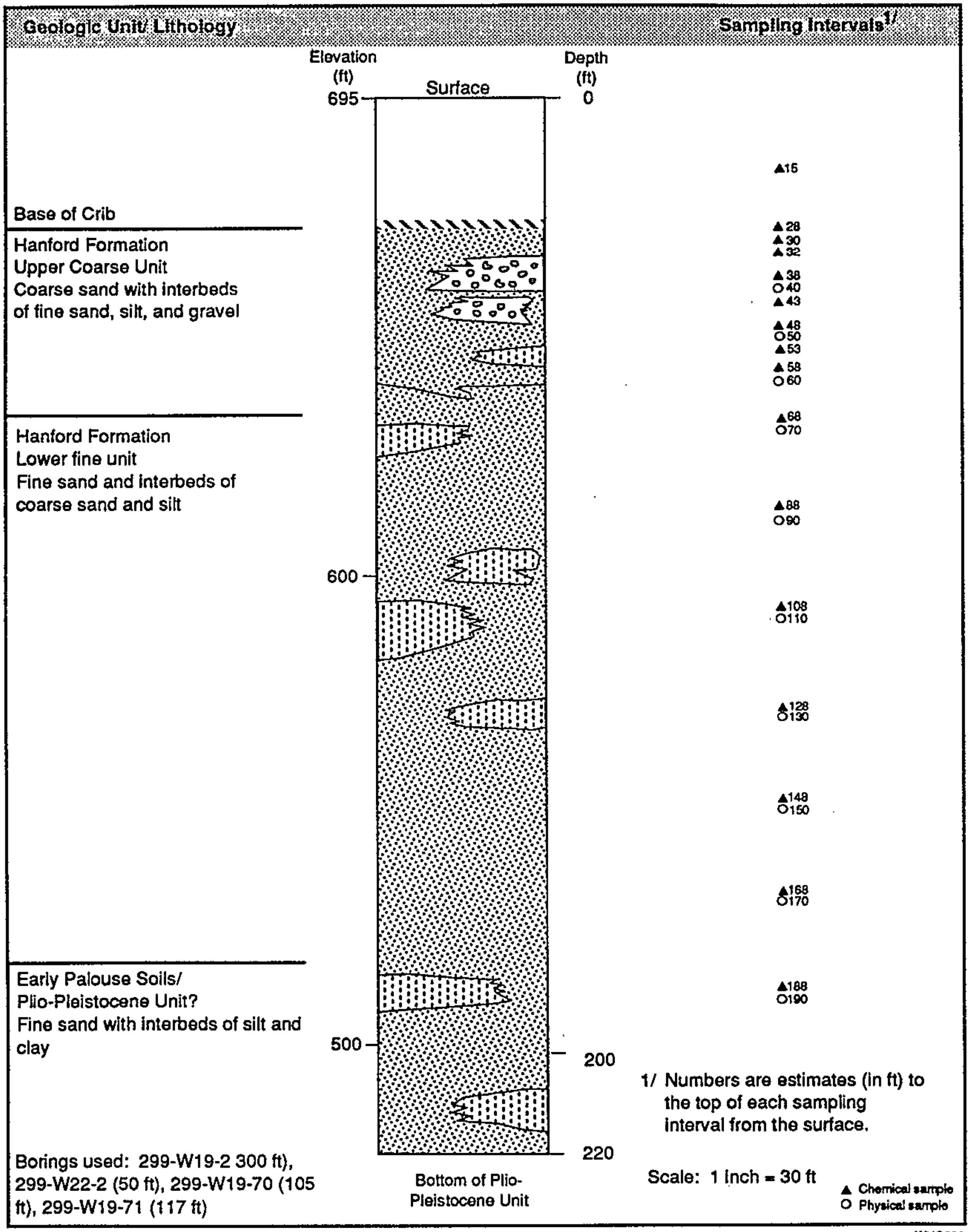


Figure 5-6. Sampling Intervals for the Boring at the 216-U-8 Crib.

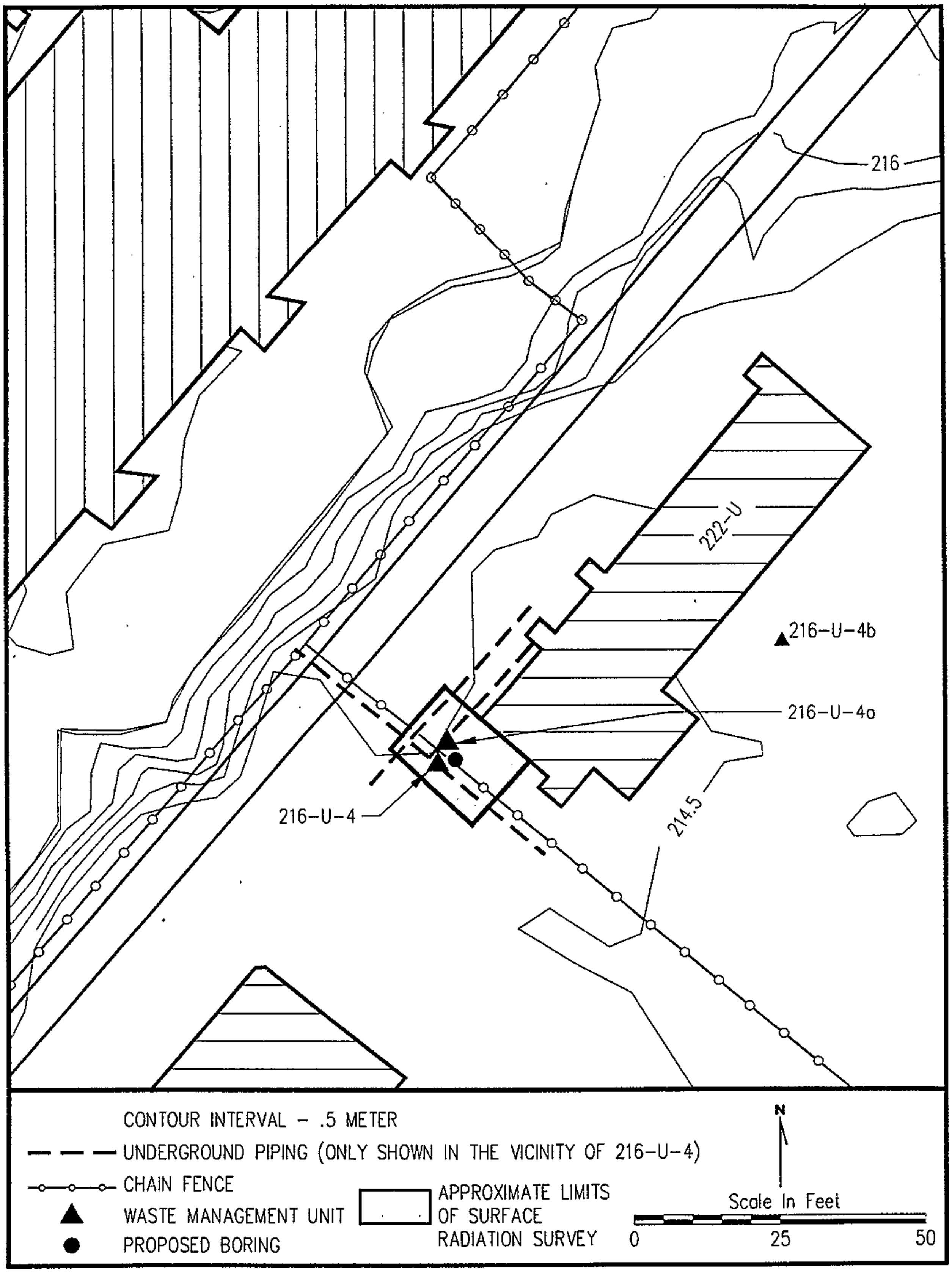


Figure 5-7. Map of the 216-U-4 Reverse Well and 216-U-4A French Drain.

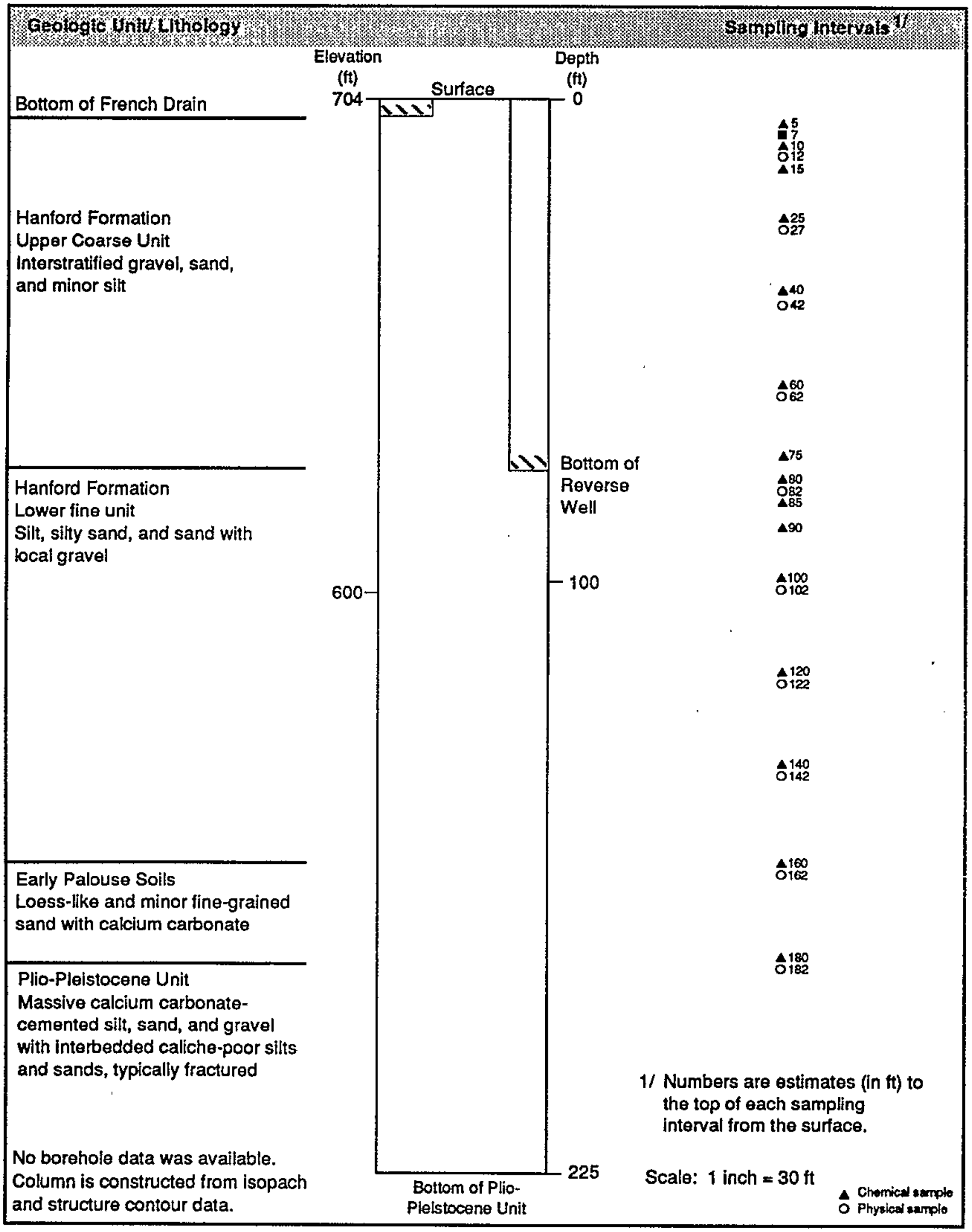


Figure 5-8. Sampling Intervals for the Boring at the 216-U-4 Reverse Well and the 216-U-4A French Drain.

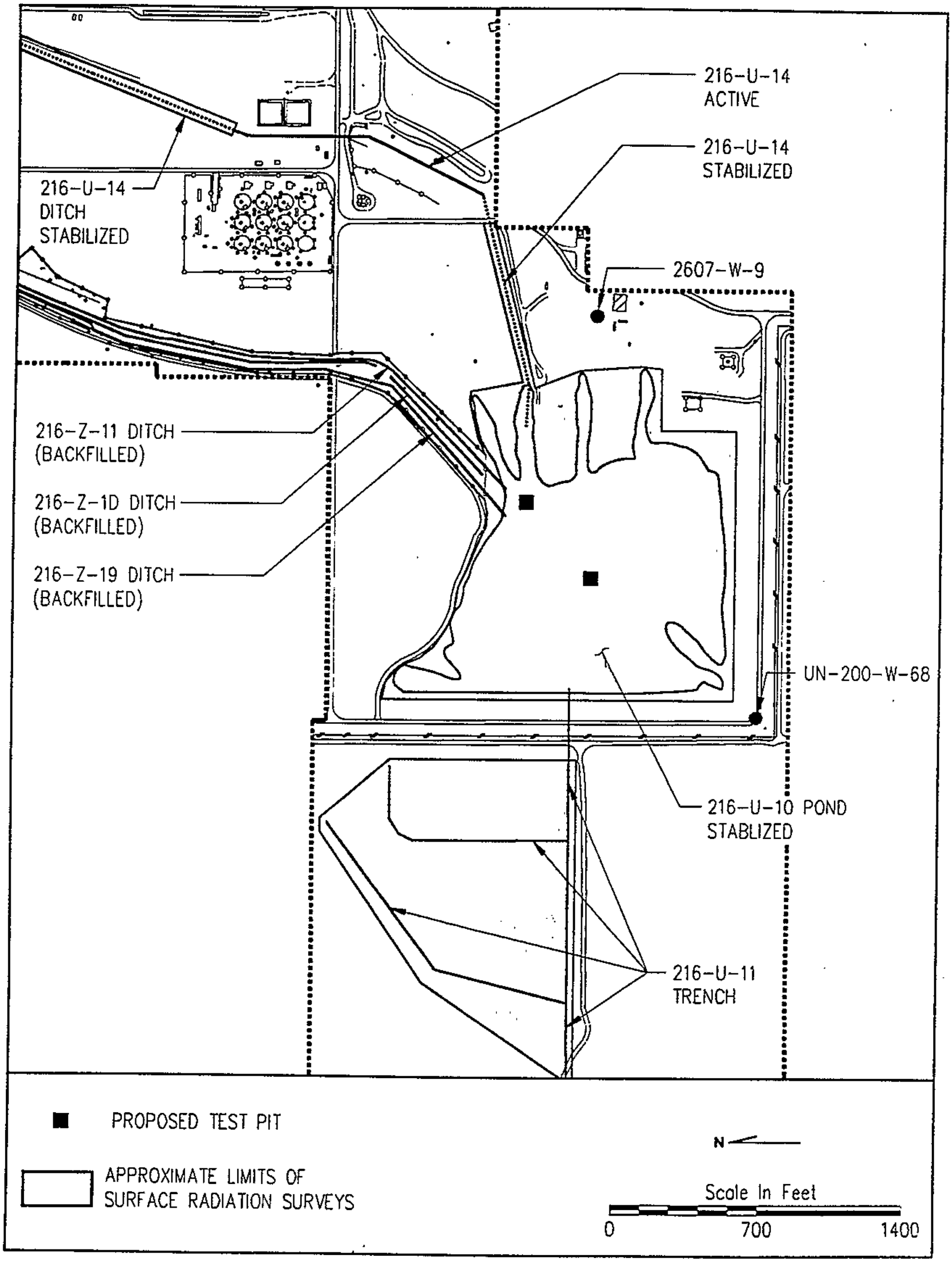


Figure 5-9. Map of the 216-U-10 Pond and its Associated Ditches. 200UP2-R

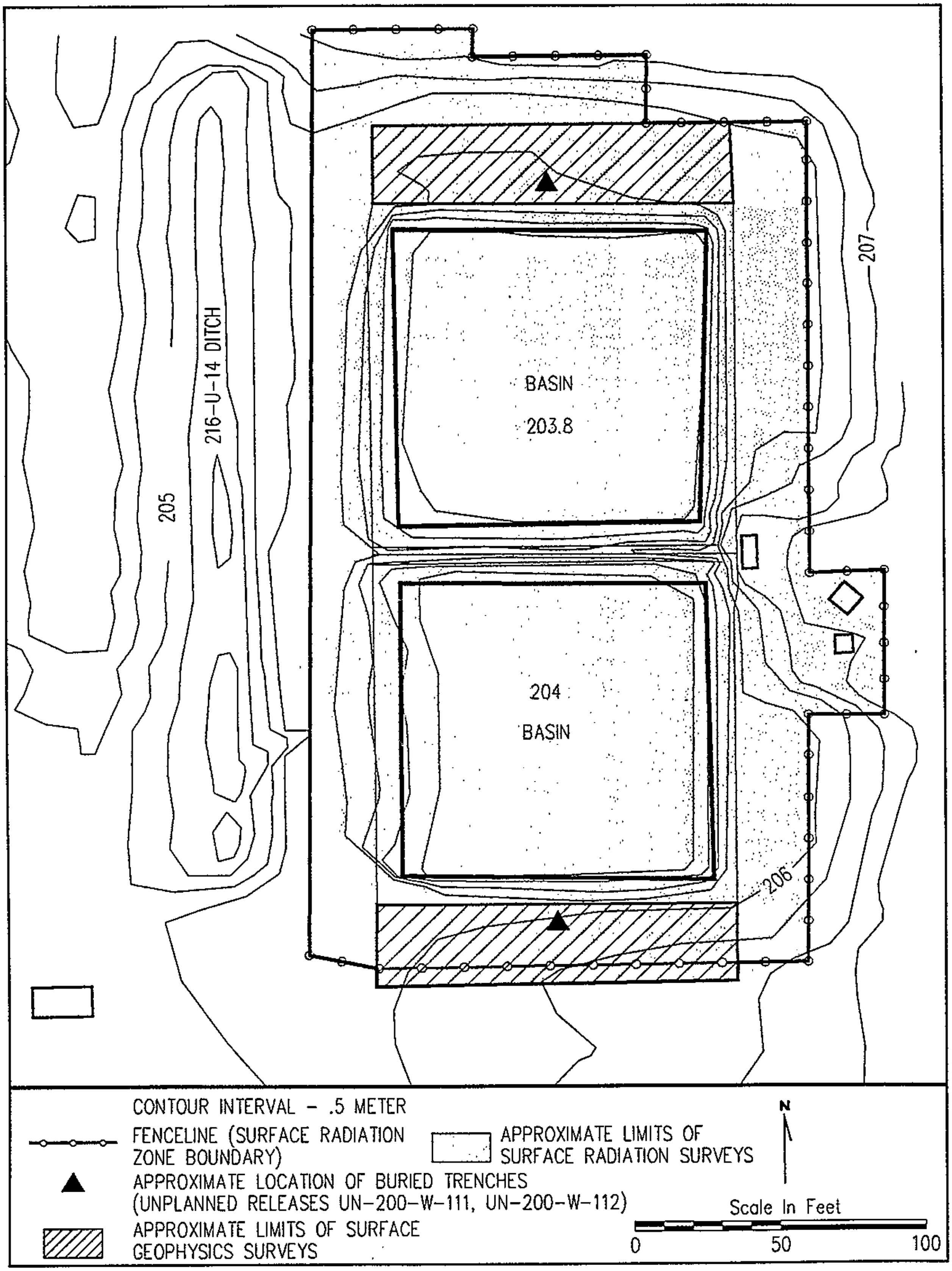


Figure 5-10. Map of the 207-U-Retention Basin.

9 2 1 2 0 1 3 2 7

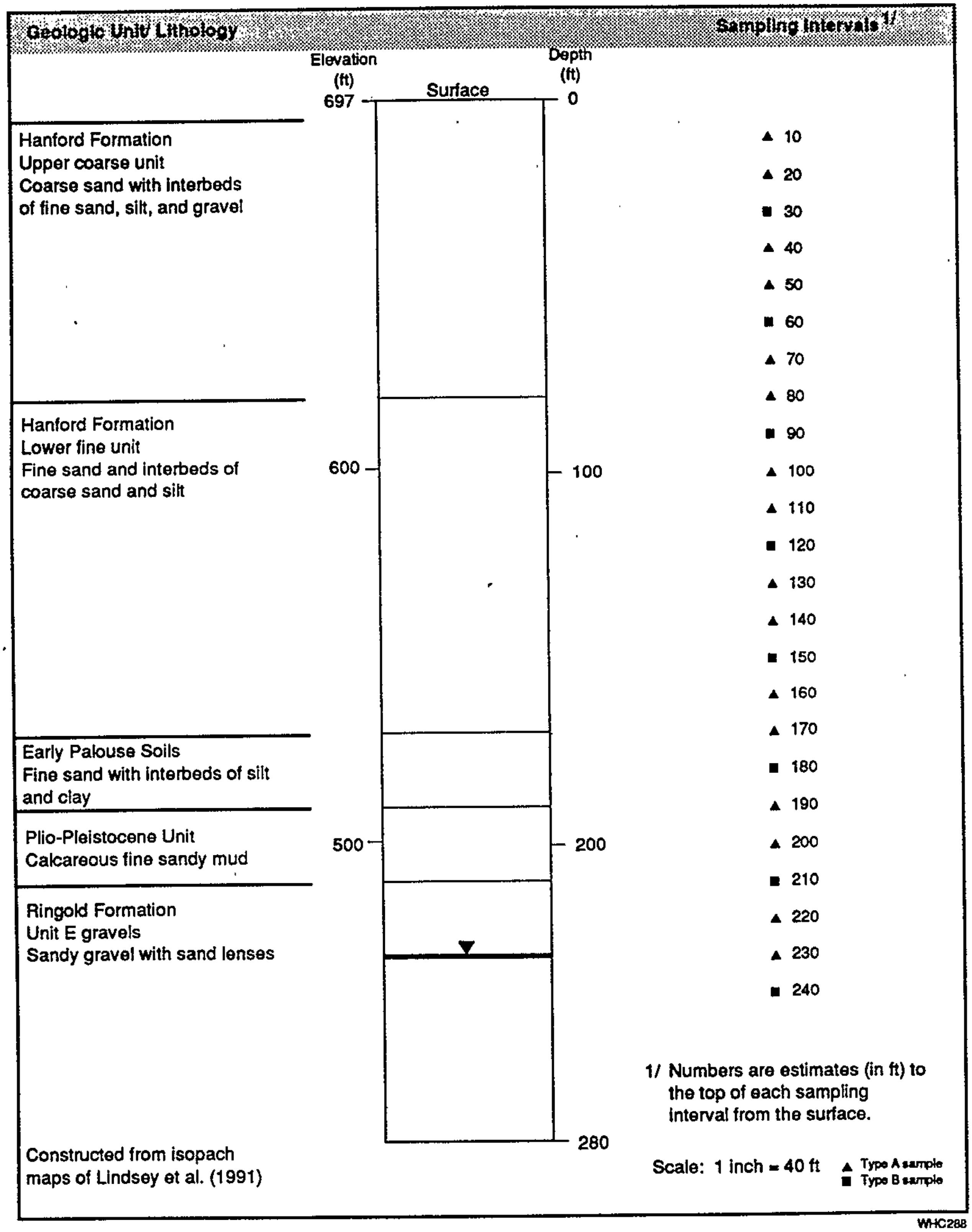


Figure 5-11. Sampling Intervals for the Vadose Zone Model Calibration Boring.

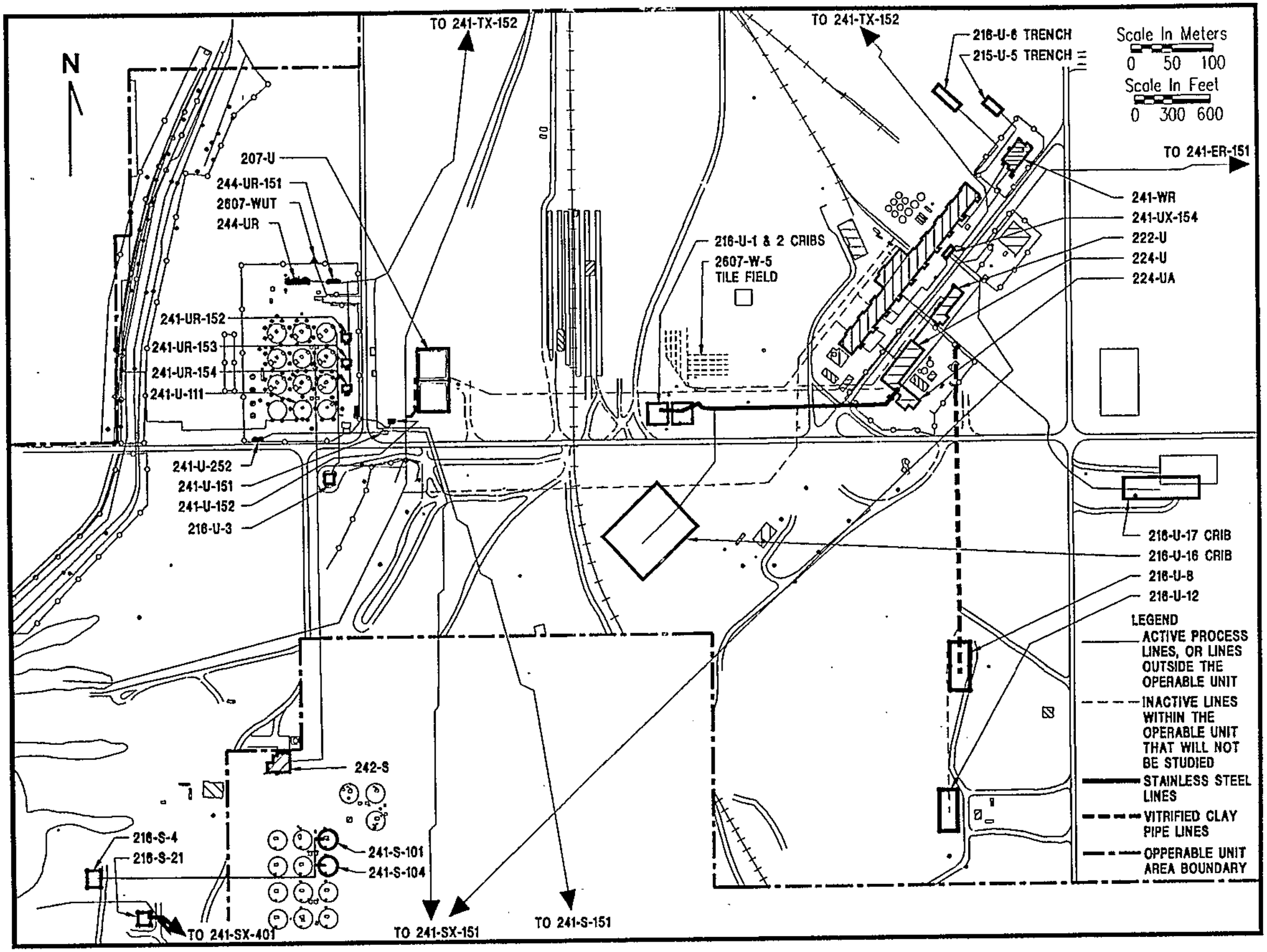


Figure 5-12. Pipeline Location Map.

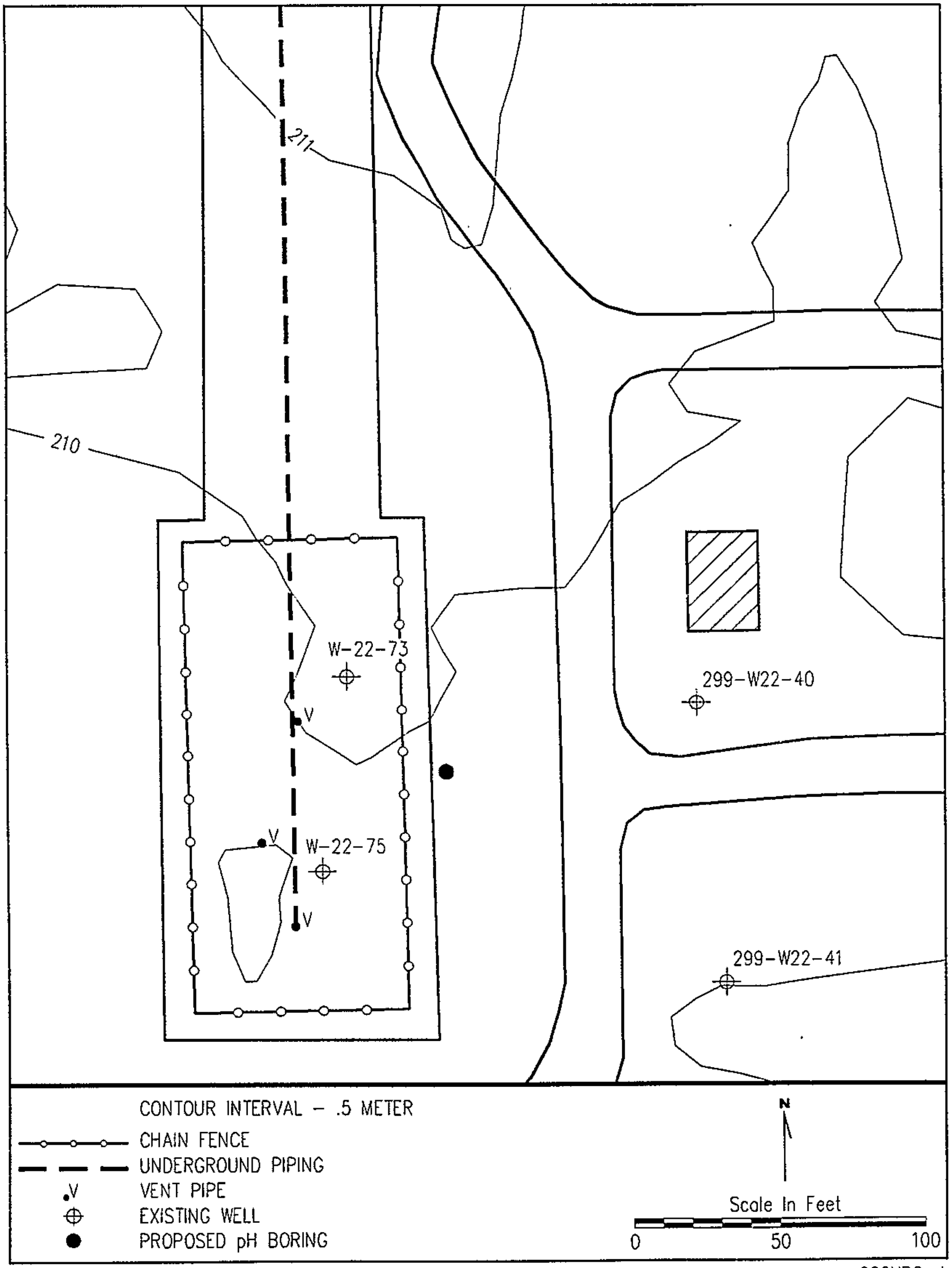


Figure 5-13. Map of the 216-U-12 Crib.

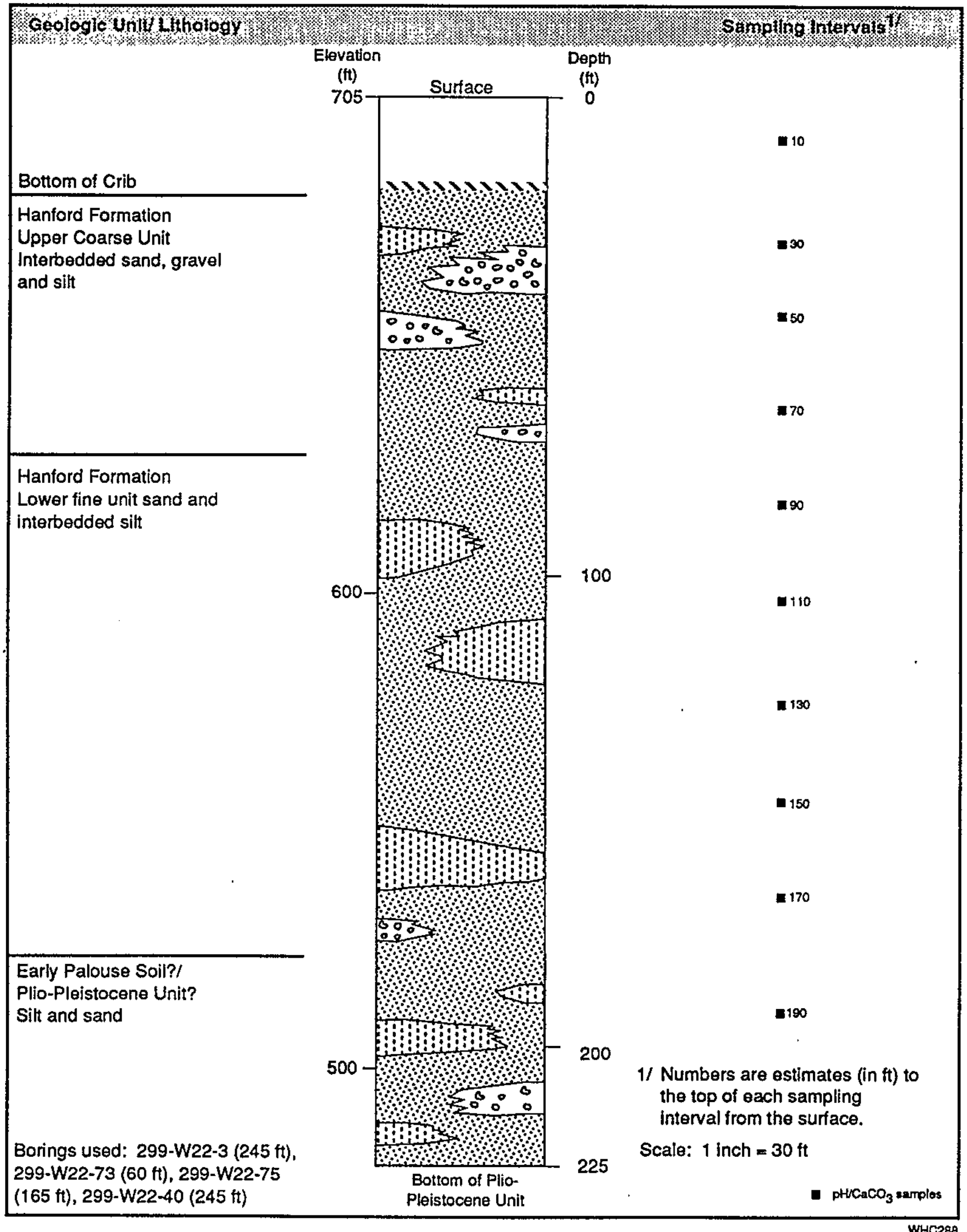


Figure 5-14. Sampling Intervals for the Boring at the 216-U-12 Crib.

Table 5-1. Relationship Between Tasks and Field Activities.

Field Sampling Plan Tasks	Source Characterization (Task 2)	Geologic Investigation (Task 3)	Surface Water Sediment Investigation (Task 4)	Vadose Zone Investigation (Task 5)	Air Investigation (Task 6)
Primary Field Activities					
Surface Radiological Surveys	X	--	--	--	--
Surface Geophysics Surveys	X	--	--	--	--
Soil Gas Surveys	X	--	--	--	--
Borings	X	X	--	X	--
Test Pits	X	X	--	X	--
Subsurface Geophysics	X	X	--	X	--
Surface Soil Sampling	X	--	--	--	--
Surface Water Sediment Sampling	X	--	X	--	--
Source Sampling	X	--	--	--	--
Perched Water Sampling	--	--	--	X	--
Air Monitoring	--	--	--	--	X
Vadose Zone Model Calibration	--	--	--	X	--
Pipeline Integrity Assessment	X	--	--	--	--
pH Boring	--	--	--	X	--

Table 5-1. Relationship Between Tasks and Field Activities. Page 2 of 2

Field Sampling Plan Tasks	Source Characterization (Task 2)	Geologic Investigation (Task 3)	Surface Water Sediment Investigation (Task 4)	Vadose Zone Investigation (Task 5)	Air Investigation (Task 6)
Supporting Field Activities					
Geodetic Surveys	X	X	X	X	X
Sample Designation and Handling	X	X	X	X	X
Decontamination	X	X	X	X	X
Waste Disposal	X	X	X	X	X

Table 5-2. Field Activities Associated with Source Characterization (Task 2).

Location / High Priority Units	Data Compilation and Review (Sutbask 2a)	Field Activities (Subtask 2b)					
		Surface Radiological Surveys (Section 5.3.2.1)	Surface Geophysics Surveys (Section 5.3.2.2)	Borings (Section 5.3.2.3)		Test Pits (Section 5.3.2.4)	
		Approximate Area	Types/Approximate Area/ Grid Spacing	Estimated Depth	Estimated Number of Chemical Samples	Estimated Depth	Estimated Number of Chemical Samples
216-U-1/U-2 Cribs (Section 5.3.1.2)	Completed	7,500 m$^{2a/}$ (80,730 ft^2)	–	49 m (160 ft) 49 m (160 ft) 49 m (160 ft)	15 10 9	–	–
216-U-8 Crib (Section 5.3.1.2)	Completed	5,800 m^2 (62,500 ft^2)	–	61 m (200 ft)	15	–	–
216-U-12 Crib (Section 5.3.1.2)	Completed	–	–	–	–	–	–
216-U-16 Crib (Section 5.3.1.2)	Completed	–	–	–	–	–	–
216-U-17 Crib (Section 5.3.1.2)	Completed	–	–	–	–	–	–
216-U-3 French Drain (Section 5.3.1.3)	Completed	–	–	–	–	–	–
216-U-4 Reverse Well & 216-U-4A French Drain (Section 5.3.1.3)	Completed	21 m^2 (225 ft^2)	–	61 m (200 ft)	14	–	–
216-U-4B French Drain (Section 5.3.1.3)	Completed	–	–	–	–	–	–
216-U-7 French Drain (Section 5.3.1.3)	Completed	–	–	–	–	–	–
216-U-10 Pond (Section 5.3.1.4)	Completed	372,000 m$^{2b/}$ (4,000,000 ft^2)	–	–	–	10 m (35 ft) 10 m (35 ft)	5 5
216-U-11 Trench (Section 5.3.1.4)	Completed	372,000 m$^{2b/}$ (4,000,000 ft^2)	–	–	–	–	–

Table 5-2. Field Activities Associated with Source Characterization (Task 2).

Location	Data Compilation and Review (Subtask 2a)	Field Activities (Subtask 2b)					
		Surface Radiological Surveys (Section 5.3.2.1)	Surface Geophysics Surveys (Section 5.3.2.2)	Borings (Section 5.3.2.3)		Test Pits (Section 5.3.2.4)	
High Priority Units		Approximate Area	Types/Approximate Area/ Grid Spacing	Estimated Depth	Estimated Number of Chemical Samples	Estimated Depth	Estimated Number of Chemical Samples
216-U-14 Ditch (Section 5.3.1.4)	Completed	372,000 m^2 b/ (4,000,000 ft^2)					
216-Z-1D Ditch (Section 5.3.1.4)	Completed	372,000 m^2 b/ (4,000,000 ft^2)	--	--	--	--	--
216-Z-11 Ditch (Section 5.3.1.4)	Completed	372,000 m^2 b/ (4,000,000 ft^2)	--	--	--	--	--
216-Z-19 Ditch (Section 5.3.1.4)	Completed	372,000 m^2 b/ (4,000,000 ft^2)	--	--	--	--	--
Pipeline Integrity Assessment (Section 5.3.1.6)	Completed	--	--	--	--	--	--
241-U-361 Settling Tank (Section 5.3.1.1)	Completed	7,500 m^2 a/ (80,730 ft^2)	--	--	--	--	--
207-U Retention Basin (Section 5.3.1.5)	Completed	6,130 m^2 (66,000 ft^2)	GPR 700 m^2/1.5 m (7,500 ft^2/5 ft)	--	--	11 m (35 ft)	4

Table 5-2. Field Activities Associated with Source Characterization (Task 2).

Location	Field Activities (Subtask 2b)					Laboratory Analysis (Subtask 2c)	Data Evaluation (Subtask 2d)
	Subsurface Geophysics (Section 5.3.2.5)		Surface Soil Sampling (Section 5.3.2.6)	Sediment Sampling (Section 5.3.2.7)	Pipeline Integrity Assessment (Section 5.3.2.11)	(Section 5.3.3)	
High Priority Units	Wells	Estimated Depths	Estimated Number of Samples	Estimated Number of Samples			
216-U-1/U-2 Cribs (Section 5.3.1.2)	new new new 299-W19-3 299-W19-9	49 m (160 ft) 49 m (160 ft) 49 m (160 ft) 70 m (230 ft) 70 m (230 ft)	4[a]	–	–	34 soil (COCs) 4 soil (COCs-VOAs)	Yes
216-U-8 Crib (Section 5.3.1.2)	new 299-W19-62[c] 299-W19-69[c] 299-W19-70 299-W19-71	61 m (200 ft) 70 m (230 ft) 70 m (230 ft) 70 m (230 ft) 70 m (230 ft)	2	–	–	16 soil (COCs) 2 soil (COCs-VOAs)	Yes
216-U-12 Crib (Section 5.3.1.2)	–	–	–	–	–	–	Yes
216-U-16 Crib (Section 5.3.1.2)	–	–	–	–	–	–	Yes
216-U-17 Crib (Section 5.3.1.2)	–	–	–	–	–	–	Yes
216-U-3 French Drain (Section 5.3.1.3)	–	–	–	–	–	–	Yes
216-U-4 Reverse Well & 216-U-4A French Drain (Section 5.3.1.3)	new	61 m (200 ft)	1	–	–	14 soil (COCs) 1 soil (COCs-VOAs)	Yes
216-U-4B French Drain (Section 5.3.1.3)	–	–	–	–	–	–	Yes
216-U-7 French Drain (Section 5.3.1.3)	–	–	–	–	–	–	Yes
216-U-10 Pond (Section 5.3.1.4)	–	–	10[c]	–	–	10 soil (COCs) 10 soil (COCs-VOAs)	Yes

Table 5-2. Field Activities Associated with Source Characterization (Task 2).

	Field Activities (Subtask 2b)					Laboratory Analysis (Subtask 2c)	Data Evaluation (Subtask 2d)
Location	Subsurface Geophysics (Section 5.3.2.5)		Surface Soil Sampling (Section 5.3.2.6)	Sediment Sampling (Section 5.3.2.7)	Pipeline Integrity Assessment (Section 5.3.2.11)	(Section 5.3.3)	
High Priority Units	Wells	Estimated Depths	Estimated Number of Samples	Estimated Number of Samples			
216-U-11 Trench (Section 5.3.1.4)	–	–	–	–	–	–	Yes
216-U-14 Ditch (Section 5.3.1.4)	–	–	–	–	–	–	Yes
216-Z-1D Ditch (Section 5.3.1.4)	–	–	–	–	–	–	Yes
216-Z-11 Ditch (Section 5.3.1.4)	–	–	–	–	–	–	Yes
216-Z-19 Ditch (Section 5.3.1.4)	–	–	–	–	–	–	Yes
Pipeline Inegrity Assessment (Section 5.3.1.6)	–	–	–	–	About 700 m (2,300 ft) of surface radiation and camera surveys also estimate 3 test pits, 6 surface soil samples, and 6 soil samples.	6 soil (COCs) 5 soil (COCs-VOAs)	Yes

Table 5-2. Field Activities Associated with Source Characterization (Task 2).

Location / High Priority Units	Field Activities (Subtask 2b): Subsurface Geophysics (Section 5.3.2.5) — Wells	Subsurface Geophysics (Section 5.3.2.5) — Estimated Depths	Surface Soil Sampling (Section 5.3.2.6) — Estimated Number of Samples	Sediment Sampling (Section 5.3.2.7) — Estimated Number of Samples	Pipeline Integrity Assessment (Section 5.3.2.11)	Laboratory Analysis (Subtask 2c) (Section 5.3.3)	Data Evaluation (Subtask 2d)
241-U-361 Settling Tank (Section 5.3.1.1)[a]	--	--	1	--	--	1 soil (COCs-VOAs)	Yes
207-U Retention Basin (Section 5.3.1.5)	--	--	2	2	--	4 soil (COCs) 4 soil (COCs-VOAs)	Yes

a/ A unified surface radiation survey covering the 216-U-1/216-U-2 Cribs, 241-U-361 Settling Tank, and 2607-W-5 Septic Tank will be conducted.

b/ This surface radiation survey will cover the 216-U-10 Pond and all of its associated ditches.

c/ The 10 surface soil samples will be collected form the U Pond and its associated ditches and trenches.

Table 5-3. Activities Associated with Geologic Investigations (Task 3). Page 1 of 3

Location / High Priority Units	Data Compilation and Review (Subtask 3a)	Field Activities (Subtask 3b): Borings (Section 5.3.2.3)[a]: Estimated Depth	Borings: Estimated number of Physical Samples	Test Pits (Section 5.3.2.4)[a]: Estimated Depth	Test Pits: Estimated Number of Physical Samples	Subsurface Geophysics (Section 5.3.2.5)[a]: Wells	Subsurface Geophysics: Estimated Depth	Laboratory Analysis (Subtask 3c): Number/type of Physical Analysis (Section 5.3.3) b/	Data Evaluation (Subtask 3d)
216-U-1/U-2 Cribs Section 5.3.1.2)	Completed	49 m (160 ft) 49 m (160 ft) 49 m (160 ft)	9 10 7	--	--	new new new 299-W19-3 299-W19-9	49 m (160 ft) 49 m (160 ft) 49 m (160 ft) 70 m (230 ft) 70 m (230 ft)	20-Type A 6-Type B	Yes
216-U-8 Crib Section (5.3.1.2)	Completed	61 m (200 ft)	10	--	--	new 299-W19-69 299-W19-70 299-W19-71 299-W22-62	49 m (160 ft) 70 m (230 ft) 70 m (230 ft) 70 m (230 ft) 70 m (230 ft)	8-Type A 2-Type B	Yes
216-U-12 Crib (Section 5.3.1.2)	Completed	--	--	--	--	--	--	--	Yes
216-U-16 Crib (Section 5.3.1.2)	Completed	--	--	--	--	--	--	--	Yes
216-U-17 Crib (Section 5.3.1.2)	Completed	--	--	--	--	--	--	--	Yes
216-U-3 French Drain (Section 5.3.1.3)	Completed	--	--	--	--	--	--	--	Yes
216-U-4 Reverse Well & 216-U-4A French Drain (Section 5.3.1.3)	Completed	61 m (200 ft)	10	--	--	new	61 m (200 ft)	8-Type A 2 Type B	Yes
216-U-4B French Drain (Section 5.3.1.3)	Completed	--	--	--	--	--	--	--	Yes

Table 5-3. Activities Associated with Geologic Investigations (Task 3). Page 2 of 3

Location	Data Compilation and Review (Subtask 3a)	Field Activities (Subtask 3b)						Laboratory Analysis (Subtask 3c)	Data Evaluation (Subtask 3d)
		Borings (Section 5.3.2.3)[a]		Test Pits (Section 5.3.2.4)[a]		Subsurface Geophysics (Section 5.3.2.5)[a]			
High Priority Units	-	Estimated Depth	Estimated number of Physical Samples	Estimated Depth	Estimated Number of Physical Samples	Wells	Estimated Depth	Number/type of Physical Analysis (Section 5.3.3) b/	
216-U-7 French Drain (Section 5.3.1.3)	Completed	–	–	–	–	–	–	–	Yes
216-U-10 Pond (Section 5.3.1.4)	Completed	–	–	11 m (35 ft) 11 m (35 ft)	1 1	–	–	2-Type A	Yes
216-U-11 Trench (Section 5.3.1.4)	Completed	–	–	–	–	–	–	–	Yes
216-U-14 Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–	–	Yes
216-Z-1D Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–	–	Yes
216-Z-11 Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–	–	Yes
216-Z-19 Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–	–	Yes
241-U-361 Settling Tank (Section 5.3.1.1	Completed	–	–	–	–	–	–	–	Yes

Table 5-3. Activities Associated with Geologic Investigations (Task 3). Page 3 of 3

	Data Compilation and Review (Subtask 3a)	Field Activities (Subtask 3b)						Laboratory Analysis (Subtask 3c)	Data Evaluation (Subtask 3d)
Location		Borings (Section 5.3.2.3)[a]		Test Pits (Section 5.3.2.4)[a]		Subsurface Geophysics (Section 5.3.2.5)[a]			
High Priority Units		Estimated Depth	Estimated number of Physical Samples	Estimated Depth	Estimated Number of Physical Samples	Wells	Estimated Depth	Number/type of Physical Analysis (Section 5.3.3) b/	
207-U Retention Basin (Section 5.3.1.6)	Completed	--	--	11 m (35 ft)	1	--	--	1-Type A	Yes

a/ These activities are related to other tasks as well (see Table 5-1).

b/ Type A samples will be run for the following analyses: moisture content, bulk density, particle-size distribution, and $CaCO_3$ content (samples from the test pits will not be run for bulk density).
Type B samples will be run for Type A analyses and saturated hydraulic conductivity, unsaturated hydraulic conductivity, cation exchange capacity, moisture retention curves, organic carbon content, iron and manganese content, pH and, if possible, Eh and mineralogy.

Table 5-4. Activities Associated with Surface Water Sediment Investigations (Task 4).

Location	Data Compilation and Review (Subtask 4a)	Field Activities (Subtask 4b): Sediment Sampling[a] (Section 5.3.2.7): Estimated Number of Samples	Laboratory Analysis (Section 5.3.3) (Subtask 4c): Number/Type of Chemical Analyses	Data Evaluation (Subtask 4d)
207-U Retention Basin (Section 5.3.1.5)	Completed	2	2 Sediment COCs	Yes

a/ This activity is also associated with the Source Characterization Task (see Table 5-1).

Table 5-5. Activities Associated with Vadose Zone Investigations (Task 5).

Location	Data Compilation and Review (Subtask 5a)	Borings (Section 5.3.2.3)[1]		Test Pits (Section 5.3.2.4)[1]		Subsurface Geophysics (Section 5.3.2.5)[1]	
High Priority Units		Estimated Depth	Estimated number of Chemical Samples	Estimated Depth	Estimated number of Chemical Samples	Wells	Estimated Depth
216-U-1/U-2 Cribs (Section 5.3.1.2)	Completed	49 m (160 ft) 49 m (160 ft) 49 m (160 ft)	15 10 9	–	–	new new new 299-W19-3 299-W19-9	49 m (160 ft) 49 m (160 ft) 49 m (160 ft) 70 m (230 ft) 70 m (230 ft)
216-U-8 Crib (Section 5.3.1.2)	Completed	61 m (200 ft)	16	–	–	new 299-W22-62 299-W19-69 299-W19-70 299-W19-71	61 m (200 ft) 70 m (230 ft) 70 m (230 ft) 70 m (230 ft) 70 m (230 ft) 70 m (230 ft)
216-U-12 Crib (Section 5.3.1.2)	Completed	–	–	–	–	–	–
216-U-16 Crib (Section 5.3.1.2)	Completed	–	–	–	–	–	–
216-U-17 Crib (Section 5.3.1.2)	Completed	–	–	–	–	–	–
216-U-3 French Drain (Section 5.3.1.3)	Completed	–	–	–	–	–	–
216-U-4 Reverse Well & 216-U-4A French Drain (Section 5.3.1.3)	Completed	61 m (200 ft)	14	–	–	new	200 ft (60 m)
216-U-4B French Drain (Section 5.3.1.3)	Completed	–	–	–	–	–	–
216-U-7 French Drain (Section 5.3.1.3)	Completed	–	–	–	–	–	–
216-U-10 Pond (Section 5.3.1.4)	Completed	–	–	11 m (35 ft) 11 m (35 ft)	5 5	–	–
216-U-11 Trench (Section 5.3.1.4)	Completed	–	–	–	–	–	–
216-U-14 Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–

Table 5-5. Activities Associated with Vadose Zone Investigations (Task 5). Page 2 of 4

	Data Compilation and Review (Subtask 5a)	Field Activities (Subtask 5b)					
Location		Borings (Section 5.3.2.3)[a]		Test Pits (Section 5.3.2.4)[a]		Subsurface Geophysics (Section 5.3.2.5)[a]	
High Priority Units		Estimated Depth	Estimated number of Chemical Samples	Estimated Depth	Estimated number of Chemical Samples	Wells	Estimated Depth
216-Z-1D Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–
216-Z-11 Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–
216-Z-19 Ditch (Section 5.3.1.4)	Completed	–	–	–	–	–	–
Other Perched Water Sample Locations (Section 5.3.1.6)	Completed	–	–	–	–	–	–
Vadose Zone Model Calibration (Section 5.3.1.6)	Completed	–	–	–	–	–	–
241-U-361 Settling Tank (Section 5.3.1.1)	Completed	–	–	–	–	–	–
207-U Retention Basin (Section 5.3.1.5)	Completed	–	–	35 ft (10 m)	4	–	–

Table 5-5. Activities Associated with Vadose Zone Investigations (Task 5).

Location	Field Activities (Subtask 5b)					Laboratory Analysis[a/] (Subtask 5c)		Data Evaluation (Subtask 5d)
Location	Perched Water Sampling (Section 5.3.2.8)	Vadose Zone Model Calibration (Section 5.3.2.9)[a/]		pH Boring (Section 5.3.2.12)		(Section 5.3.3)		
High Priority Units	Wells	Estimated Depth	Estimated Number of Physical Samples	Estimated Depth	Estimated Number of Physcial Samples	Number of Physical Analyses[b/]	Number of Chemical analyses	
216-U-1/U-2 Cribs (Section 5.3.1.2)	new new new	--	--	--	--	--	3 water COCs 34 soil COCs	Yes
216-U-8 Crib (Section 5.3.1.2)	new	--	--	--	--	--	1 water COCs 16 soil COCs	Yes
216-U-12 Crib (Section 5.3.1.2)	--	--	--	180 ft	10	10 pH and $CaCO_3$	--	Yes
216-U-16 Crib (Section 5.3.1.2)	--	--	--	--	--	--	--	Yes
216-U-17 Crib (Section 5.3.1.2)	--	--	--	--	--	--	--	Yes
216-U-3 French Drain (Section 5.3.1.3)	--	--	--	--	--	--	--	Yes
216-U-4 Reverse Well & 216-U-4A French Drain (Section 5.3.1.3)	new	--	--	--	--	--	1 water COCs 14 soil COCs	Yes
216-U-4B French Drain (Section 5.3.1.3)	--	--	--	--	--	--	--	Yes
216-U-7 French Drain (Section 5.3.1.3)	--	--	--	--	--	--	--	Yes
216-U-10 Pond (Section 5.3.1.4)	--	--	--	--	--	--	10 soil COCs	Yes
216-U-11 Trench (Section 5.3.1.4)	--	--	--	--	--	--	--	Yes
216-U-14 Ditch (Section 5.3.1.4)	--	--	--	--	--	--	--	Yes

Table 5-5. Activities Associated with Vadose Zone Investigations (Task 5). Page 4 of 4

	Field Activities (Subtask 5b)					Laboratory Analysis[a/] (Subtask 5c)		Data Evaluation (Subtask 5d)
Location	Perched Water Sampling (Section 5.3.2.8)	Vadose Zone Model Calibration (Section 5.3.2.9)[a/]		pH Boring (Section 5.3.2.12)		(Section 5.3.3)		
High Priority Units	Wells	Estimated Depth	Estimated Number of Physical Samples	Estimated Depth	Estimated Number of Physcial Samples	Number of Physical Analyses[b/]	Number of Chemical analyses	
216-Z-1D Ditch (Section 5.3.1.4)	--	--	--	--	--	--	--	Yes
216-Z-11 Ditch (Section 5.3.1.4)	--	--	--	--	--	--	--	Yes
216-Z-19 Ditch (Section 5.3.1.4)	--	--	--	--	--	--	--	Yes
Other Perched Water Sample Locations (Section 5.3.2.11)	299-W19-22 299-W19-91 299-W19-92 299-W19-93	--	--	--	--	--	4 water COCs	Yes
Vadose Zone Model Calibration (Section 5.3.2.12)	--	230 ft (70 m)	25	--	--	17-Type A 8-Type B	--	Yes
241-U-361 Settling Tank (Section 5.3.1.1)	--	--	--	--	--	--	--	Yes
207-U Retention Basin (Section 5.3.1.5)	--	--	--	--	--	--	4 soil COCs	Yes

a/ These activities are related to other tasks as well (see Table 5-1).
b/ Type A samples will be run for the following analyses: moisture content, bulk density, particle-size distribution, and $CaCO_3$ content.
Type B samples will be run for Type A analyses and saturated hydraulic conductivity, cation exchange capacity, organic carbon content, iron and manganese content, pH, and if possible, Eh and mineralogy.

Table 5-6. Activities Associated with Air Investigations (Task 6).

Location (Section 5.3.1.6.4)	Data Compilation and Review (Subtask 6a)	Field Activities (Subtask 6b) Air Sampling (Section 5.3.2.10)	Laboratory Analysis (Section 5.3.3) (Subtask 6c)	Data Evaluation (Subtask 6d)
High Priority Units[a]		Estimated Number of Samples	Number/Type of Chemical Analyses	
155 165 168 975	Completed	Quarterly during field activities	4 samples each quarter for Co-90, Sr-137, Pu-238, Pu-239, Pu-240, U, gross beta, and gross alpha	Yes

[a] EDP Location Code

Table 5-7. Summary of Site-Specific Field Activities for Each Waste Management Unit

Waste Management Unit	Primary Field Activities									Supporting Field Activities			
	Surface Radiological Surveys	Surface Geophysical Surveys	Borings	Test Pits	Subsurface Geophysics	Surface Soil Sampling	Surface Water Sediment Sampling	Perched Water Sampling	pH Boring	Geodetic Surveys	Sample Designation & Handling	Decontamination	Investigation Derived Waste Disposal
216-U-1 & 216-U-2 Cribs[a]	X	–	3	–	X	X	–	X	–	X	X	X	X
216-U-8 Crib	X	–	1	–	X	X	–	X	–	–	X	X	X
216-U-12 Crib	–	–	–	–	–	–	–	–	X	–	–	–	–
216-U-16 Crib	–	–	–	–	–	–	–	–	–	–	–	–	–
216-U-17 Crib	–	–	–	–	–	–	–	–	–	–	–	–	–
216-U-3 French Drain	–	–	–	–	–	–	–	–	–	–	–	–	–
216-U-4 Reverse Well & 216-U-4A French Drain	X	–	1	–	X	X	–	X	–	X	X	X	X
216-U-4B French Drain	–	–	–	–	–	–	–	–	–	–	–	–	–
216-U-7 French Drain	–	–	–	–	–	–	–	–	–	–	–	–	–
216-U-10 Pond	X	–	–	2	X	X	–	–	–	X	X	X	X
216-U-11 Trench	X	–	–	–	–	X	–	–	–	X	X	X	X
216-U-14 Ditch	X	–	–	–	–	X	–	–	–	X	X	X	X
216-Z-1D Ditch	X	–	–	–	–	X	–	–	–	X	X	X	X
216-Z-11 Ditch	X	–	–	–	–	X	–	–	–	X	X	X	X
216-Z-19 Ditch	X	–	–	–	–	X	–	–	–	X	X	X	X
241-U-361 Settling Tank	X	–	–	–	–	X	–	–	–	X	X	X	X

Table 5-7. Summary of Site-Specific Field Activities for Each Waste Management Unit

Waste Management Unit	Primary Field Activities									Supporting Field Activities			
	Surface Radiological Surveys	Surface Geophysical Surveys	Borings	Test Pits	Subsurface Geophysics	Surface Soil Sampling	Surface Water Sediment Sampling	Perched Water Sampling	pH Boring	Geodetic Surveys	Sample Designation & Handling	Decontamination	Investigation Derived Waste Disposal
207-U Retention Basin	X	X	--	1	--	X	X	--	--	X	X	X	X

a/ One of the borings associated with the 216-U-1 and 216-U-2 Cribs will also yield information on the 2607-W5 Septic Tank and Drain Field.

Table 5-8. Sample Types and Analytes at Each Waste Management Unit.

Waste Management Unit	Types of Samples	Chemical Analytes to be Tested	Physical Analyses
241-U-361 Settling Tank	Surface soil	TA[a]	NS
216-U-1/216-U-2 Cribs	Surface soil, vadose soil, perched water	TA[a]	Types A and B[b]
216-U-8 Crib	Surface soil, vadose soil, perched water	TA[a]	Types A and B
216-U-12 Crib	Vadose soil	NS	pH, $CaCO_3$
216-U-16 Crib	NS	NS	NS
216-U-17 Crib	NS	NS	NS
216-U-3 French Drain	NS	NS	NS
214-U-4A French Drain 216-U-4 Reverse Well	Surface soil, vadose soil, perched water	TA	Types A and B
216-U-4B French Drain	NS	NS	NS
216-U-7 French Drain	NS	NS	NS
216-U-10 Pond	Surface soil, vadose soil	TA[a]	Type A
216-U-14 Ditch	Surface soil	TA[a]	NS
216-Z-1D Ditch	Surface soil	TA[a]	NS
216-Z-11 Ditch	Surface soil	TA[a]	NS
216-Z-19 Ditch	Surface soil	TA[a]	NS
216-U-11 Trench	Surface soil	TA[a]	NS
207-U Retention Basin	Surface soil, vadose soil, sediment	TA[a]	Type A
Pipeline Integrity Samples	Surface soil, vadose soil	TA[a]	NS

a/ Surface soil will receive analysis for all target analytes (TA) except volatile organics.
b/ Type A analyses include: Bulk density, particle size distribution, moisture content and $CaCO_3$ content. Type B analyses include the four Type A analyses and saturated hydraulic conductivity, unsaturated hydraulic conductivity, matric potential in soil moisture retention curves, particle density, cation exchange capacity and organic carbon content.
NS Not Sampled

Table 5-9. Analytical Methods for Target Analytes.

Analyte[a/]	General Analytical Technique[b/]	Soil and Sediment Analysis Method[c/]	Liquid Analysis Method[c/]	Comments
Gross Alpha		900.0M	900.0	--
Gross Beta		900.0M	900.0	--
Antimony-126m	Gamma Spectrometry	D3649M	D3649M	
Cesium-134		D3649M	D3649M	--
Cesium-137		D3649M	D3649M	Cs-137 measured by counting Ba-137m
Cobalt-60		D3649M	D3649M	--
Europium-152		D3649M	D3649M	--
Europium-154		D3649M	D3649M	--
Europium-155		D3649M	D3649M	--
Neptunium-239		D3649M	D3649M	--
Potassium-40		D3649M	D3649M	--
Protactinium-231		D3649M	D3649M	--
Protactinium-234m		D3649M	D3649M	--
Ruthenium-106		D3649M	D3649M	--
Thorium-231		D3649M	D3649M	May also use alpha or beta counting
Sodium-22		D3649M	D3649M	--
Americium-241	Alpha Spectrometry	Am-01	Am-03	May also use gamma spectrometry
Americium-243		Am-01	Am-03	May also use progeny Np-239 measured by gamma spectrometry
Curium-244		907.0M	907.0	--
Neptunium-237		907.0M	907.0	--
Plutonium-238		Pu-02	Pu-10	--

Table 5-9. Analytical Methods for Target Analytes.

Analyte[a]	General Analytical Technique[b]	Soil and Sediment Analysis Method[c]	Liquid Analysis Method[c]	Comments
Plutonium-239/240		Pu-02	Pu-10	--
Thorium-229		00.06	00-07	--
Thorium-230	Alpha	00.06	00-07	--
Uranium-233[d]	Spectrometry	U	908.0	--
Uranium-234[d]		U	908.0	--
Uranium-235/236[d]		U	908.0	--
Uranium-238[d]		U	908.0	--
Iodine-129	Beta	902.0M	902.0	--
Strontium-90	Counting[e]	SR-02	SR-02	Sr-90 measured by counting Y-90
Technetium-99		TC-01M	TC-01	--
Acetone		8240	8240	--
Carbon Tetrachloride		8240	8240	--
Chloroform	Volatile	8240	8240	--
Methylene Chloride	Organic	8240	8240	--
MIBK (hexone)	Analysis	8240	8240	--
1,1,1 Trichloroethane		8240	8240	--
Toluene		8240	8240	--
Barium		6010	6010	--
Beryllium		600	610	--
Boron	ICP	6010	6010	--
Cadmium	Analysis	6010	6010	--

Table 5-9. Analytical Methods for Target Analytes.

Analyte[a]	General Analytical Technique[b]	Soil and Sediment Analysis Method[c]	Liquid Analysis Method[c]	Comments
Chromium		6010	6010	--
Copper		6010	6010	--
Iron		6010	6010	--
Lead		6010	6010	--
Manganese		6010	6010	--
Nickel	ICP	6010	6010	--
Selenium	Analysis	6010	6010	--
Silver		6010	6010	--
Titanium		6010	6010	--
Vanadium		6010	6010	--
Zinc		6010	6010	--
Arsenic		7061	7061	--
Cyanide		9010	335.3	--
Tributyl Phosphate		TBD	TBD	--
Selenium-79	Beta	TBD	TBD	--
Samarium-151	Counting[e]	TBD	TBD	--
Zirconium-93		TBD	TBD	--
Mercury		7471	245.2	--
Kerosene	Total Extractable Petroleum Hydrocarbons	8015	8015	--
Nitrate	--	300	300	--

Table 5-9. Analytical Methods for Target Analytes.

Analyte[a]	General Analytical Technique[b]	Soil and Sediment Analysis Method[c]	Liquid Analysis Method[c]	Comments
Nitrite	--	300	300	--
Additional Analyses for Water Samples Only				
Fluoride		--	300	--
Carbon-14	Beta	--	C-01	--
Tritium	Counting[e]	--	906.0	--

TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
"Prescribed Procedures for Measurement of Radioactivity in Drinking Water"(EPA 1980a)
"Test Methods for Evaluating Solid Waste"(SW 846)Third Edition (EPA 1986)
"Methods for Chemical Analysis of Water and Waste"(EPA 1983)
"Radionuclide Method for the Determination of Uranium in Soil and Air"(EPA 1980b)
"EML Procedures Manual"(DOE/EML 1990)
"Eastern Environmental Radiation Facility RadioChemistry Procedures Manual"(EPA 1984)
"High-Resolution Gamma-Ray Spectrometry of Water"(ASTM 1985)

[a] In addition to the analytes listed in this table, there are many progeny isotopes whose concentrations may be derived from known parent concentrations. These isotopes include Ba-137m, Bi-210, Be-210, Bi-211, Bi-213, Bi-214, Fr-221, Pb-209, Pb-211, Pb-212, Pb-214, Po-214, Po-218, Pu-241, and Tl-207. These concentrations will be concentrated based upon laboratory results.

[b] The analytical techniques are listed in the order that they should be performed. Gross alpha and gross beta will always be done first. Gamma Spectrometry will be done next because it generally does not require destruction of any sample. Alpha spectrometry, Sr-90 and Tc-99 analyses will next be done if sufficient sample exists. The sample for volatile organic analysis (VOAs) must be preserved and shipped in a special manner, so a decision must be made in the field that sufficient sample exists to do the preceding analyses before a VOA sample is taken. The next priority is to perform ICP analyses. Approximately 2 lbs (1 kg) of material will be required to perform these primary analyses. If more sample exists, then several additional, secondary analyses may be performed. These are shown on the table below the ICP analysis.

[c] These analytical methods should be considered examples of possible analytical techniques to use. Individual labs may have other techniques developed for some analytes.

[d] The uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m analyses. Two samples from each deep boring and one sample from each test pit or shallow boring will undergo this confirmatory analysis. No uranium analyses will be done on surface soil or sediment samples.

[e] Analytes that will be studied by beta counting are listed in the order that they should be analyzed. For instance, the Sr-90 analysis should be made first, followed by the Tc-99 analysis.

6.0 REMEDIAL ALTERNATIVES DEVELOPMENT, SCREENING, AND ANALYSIS

Based on the *Hanford Site Past-Practice Strategy*, as outlined in Section 1.0, two paths exist that lead to a FS. The first path is based on an IRM and the second path is based on a final remedy selection. Either path will lead to conducting a FS based on interim EPA guidance (EPA 1988a).

As outlined in Section 1.0, candidate waste management units for IRMs have been selected. The data necessary to select an IRM for these units will be gathered during unit-specific LFIs. These data will be used for interim remedial alternative selection in site-specific focused feasibility studies. For the waste management units not determined as candidates for an IRM, data necessary to select a final remedy will be obtained during a RI. These data will then be used for remedial alternative selection in an aggregate area FS.

6.1 ALTERNATIVES DEVELOPMENT

The objective of the FFS is to develop a range of potential remedial action alternatives that are protective of human health and the environment based on refinement of the preliminary remedial alternatives developed before the LFI activities (Section 7.0 of the U Plant Source AAMSR), data gathered during the LFI, and the results of the qualitative risk assessment. The alternatives developed during the FFS based on this information (i.e., contaminant type and geologic characteristics) will then be evaluated or screened against three criteria: effectiveness, implementability, and relative cost. Those alternatives rating highest after screening will be carried over to the remedial alternatives analysis.

The general identification of remedial action objectives (RAOs), general response actions, remedial technologies, and a preliminary list of remedial alternatives for the 200-UP-2 Operable Unit is presented in Section 7.0 of the U Plant Source AAMSR. These response actions, technologies, and alternatives are considered preliminary and will be modified, as appropriate, based on the evaluation of LFI data and the qualitative risk assessment. This section discusses how these preliminary identified remedial measures will be refined following EPA guidance (EPA 1988a). The development of interim remedial action alternatives will be accomplished in the following steps:

- Refinement of preliminary RAOs
- Refinement of preliminary general response actions
- Final identification of potential remediation technologies

- Evaluation of process options for each potential remediation technology

- Assembly of final interim remedial action alternatives

- ARARs refinement.

Each step is summarized below. Additional details can be found in EPA's interim final RI/FS guidance document (EPA 1988a).

6.1.1 Development of Remedial Action Objectives

The preliminary RAOs will be re-evaluated and finalized to discuss environmental medium-specific or source-specific goals for protecting human health and the environment. The environmental media of concern are surface soil, surface water, vadose zone soil, perched groundwater, air and biota. Contaminants of concern, exposure routes, receptors, and acceptable contaminant levels or ranges of levels for each exposure route will be specified for each medium at each site. Acceptable contaminant levels will be based on identified chemical-specific ARARs, advisory or "to-be-considered" criteria, or results of the qualitative risk assessment.

6.1.2 Development of General Response Actions

Final general response actions, which are broad classifications of actions or combinations of actions that will satisfy the RAOs, will be developed from the preliminary general response actions on a medium-specific basis. Examples of general response actions are no action, institutional controls, disposal, extraction, excavation, containment, and treatment. The waste management units and waste characteristics for the 200-UP-2 Operable Unit for which the general response actions are appropriate will be evaluated as part of this task. Considered in this evaluation will be the radiological, chemical, and physical conditions to which general response actions might be applied.

6.1.3 Identification of Potential Remediation Technologies

A final list of potential remedial technologies will be developed for each identified general response action. A preliminary list of some applicable technologies is presented in Section 7.0 of the U Plant Source AAMSR. The identified technologies and process options may not all be suitable for use at the 200-UP-2 Operable Unit. First, the identified options will be evaluated for technical implementation. This is determined by comparing the capabilities of each process option to the physical and chemical characteristics of the waste management units within the operable unit. Sometimes an entire technology may be eliminated because its process options are not technically implementable. The rationale for screening each remediation technology will be documented.

6.1.4 Evaluation of Process Options

Once identified, options are evaluated for technical implementation. The second step involves a closer evaluation of the process options associated with each remaining technology. Process options will be evaluated on the basis of effectiveness, implementability, and relative cost.

The effectiveness evaluation will focus on:

- The potential effectiveness of the process options in handling the estimated areas or volumes of the contaminated medium and attaining the remedial action objectives for that medium

- The degree that human health and the environment may be compromised during construction and implementation required by the process option

- How proven and reliable the process option is with respect to the contaminants and conditions at the waste management units within the 200-UP-2 Operable Unit.

Both technical and institutional implementability are considered in evaluating process options. Technical implementability will eliminate those options that are clearly ineffective or unworkable at the 200-UP-2 Operable Unit. Institutional considerations include the ability to obtain necessary permits for any offsite actions; the ability to meet substantive requirements of relevant permits for onsite actions; the availability and capacity of appropriate treatment, storage, and disposal services; and the availability of essential equipment and skilled labor.

Cost will be an evaluation criterion. Relative order of magnitude capital, operations and maintenance costs, as opposed to detailed estimates, will be determined based on engineering judgement. Processes within the same technology type will be compared with respect to cost.

Innovative technologies may be applicable at the 200-UP-2 Operable Unit. Should an innovative technology exhibit fewer environmental impacts, better treatment, or lower costs over a conventional technology, it could progress through the screening process.

Applicable technologies with one or more feasible process options will be used in developing remedial action alternatives. Multiple process options based on one technology may be chosen if they are significantly different and the result of one would not adequately represent the other. If possible, one representative process from each technology will be selected to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. Process options that are not selected for development, generally, will not be considered later in the FFS. However, they may be reinvestigated during remedial design if the associated technology is selected for implementation at the 200-UP-2 Operable Unit.

6.1.5 Assembly of Remedial Action Alternatives

Preliminary alternatives will be re-evaluated and further developed for each contaminated environmental medium of concern based on the results of the LFI and the qualitative risk assessment. This will involve assembling medium-specific process options, remedial technologies, and general response actions.

Section 121(b)(1) of CERCLA has a statutory preference for permanent treatment and significant waste volume reduction; therefore, the selection of remedial action alternatives that involve treatment and reduction of the contamination will be considered more acceptable than the selection of waste removal and offsite disposal alternatives.

6.1.6 Identification of Applicable or Relevant and Appropriate Requirements

A preliminary identification of potential ARARs was developed as part of the U Plant Source AAMSR (Section 6.0). These ARARs will be re-examined after the remedial action alternatives have been assembled to eliminate options that are not desirable or feasible based on regulatory requirements.

6.2 REMEDIAL ACTION ALTERNATIVES SCREENING

Screening follows the development of alternatives and precedes analysis. The objective of screening the alternatives is to reduce the list of potential remedial action alternatives to a manageable level. The potential remedial action alternatives will be evaluated in greater detail, based on effectiveness, implementability, and cost. The refined alternatives that best attain the RAOs will then be retained for detailed analysis.

The following is a summary of the alternative screening process. Further details can be found in the draft RI/FS guidance (EPA 1988a).

6.2.1 Refinement of Remedial Action Alternatives

The remedial action alternatives will be further refined to identify details of process options, process sizing requirements, time frames, and the ability to attain the RAOs. The LFI information will more accurately identify the nature and extent of contamination so that suitable equipment, technologies, and process options can be evaluated.

The specific types of information that will be developed under this task for the technologies and process options used in each alternative will be as follows:

- Size and configuration of onsite removal and treatment systems
- Identification of contaminants that impose the most demanding treatment requirements
- Size and configuration of containment structures
- Time frame in which treatment, containment, or removal goals can be achieved
- Treatment rates or flow rates associated with treatment processes
- Special requirements for construction of treatment or containment structures, staging construction materials, or excavation
- Distances to disposal facilities
- Required permits and imposed limitations.

All information and assumptions used in generating this information will be thoroughly documented.

6.2.2 Screening Evaluation of Alternatives

The remedial action alternatives will be screened with regard to the short- and long-term effectiveness, implementability, and cost. An evaluation of innovative alternatives will also be made and comparisons will be made among similar alternatives. The most promising alternatives will be carried forward for further analysis, and then distinctions across the entire range of alternatives will be made.

Alternatives will be retained that have the most favorable composite evaluation. The selections, to the extent practicable, will preserve the range of appropriate alternatives based on the general response actions. Ten or fewer alternatives that address all types of waste management units within the 200-UP-2 Operable Unit are expected to be retained. Additional alternatives may be needed if offsite disposal, as opposed to operable unit-specific, alternatives are developed and preferred. Alternatives not selected may be reconsidered if new information shows additional advantages.

6.2.2.1 Effectiveness Evaluation. Each alternative will be evaluated on the basis of its ability to protect human health and the environment through reductions in toxicity, mobility, or waste volume. Short-term protection needed during the construction and operation period, and long-term protection needed after completion of the remedial action alternative, will be evaluated. Sensitivity analyses will be prepared to evaluate probable performance.

Residual contaminant levels remaining after a reduction of waste toxicity, mobility, or volume will be compared to contaminant-specific ARARs, pertinent to consider values, and levels established through risk assessment calculations.

6.2.2.2 Implementability Evaluation. Implementability is a measure of both the technical and institutional feasibility of accomplishing an operable unit remedial alternative. Technical feasibility refers to the ability to construct, operate, meet action-specific ARARs, and maintain and monitor the technologies or process options. Institutional feasibility refers to the ability to obtain approvals from appropriate agencies and to procure required services, equipment, and personnel.

Alternatives deemed not technically feasible will be dropped from consideration. If agency approval is necessary for an institutionally infeasible alternative, the alternative will not be dropped from further consideration. In the latter situation, the remedial alternative will be retained, if possible, with the incorporation of appropriate coordination steps needed to lessen its negative aspects.

6.2.2.3 Cost Evaluation. Comparative cost estimates will be made. Cost estimates will be based on cost curves, generic unit costs, vendor information, conventional cost-estimating guides, and prior similar estimates. Both capital and operating and maintenance costs will be considered where appropriate. Present worth analyses will be used to evaluate expenditures that occur over different time periods, so the costs for different remedial alternatives can be compared on the basis of a single figure for each.

6.2.2.4 Evaluation of Innovative Alternatives. Innovative technologies will be considered if they are fully developed but lack sufficient cost or performance data for routine use. It is unlikely that alternatives that incorporate innovative technologies will be evaluated as thoroughly as is done with available technologies. However, innovative technologies will pass through the screening phase if they offer promise of significant advantages. The need for treatability studies on retained innovative technologies will be determined in conjunction with the evaluation of data needs.

6.2.3 Verification of Action-Specific Applicable or Relevant and Appropriate Requirements

Identification of action-specific ARARs will be made easier by the new information gathered on technologies and configurations during the screening process. The ARARs previously identified will be refined by project staff with input from Ecology and EPA. Regulatory agency participation will provide project focus and direction and expedite the FS.

In the process of refining remedial action alternatives, additional data needs may be identified. An assessment will be made as to their value to the 200-UP-2 Operable Unit conceptual model or alternative evaluation criteria. Data needs may require that treatability studies be conducted.

6.2.4 Evaluation of Data Needs

Additional site characterization data needs may develop during the screening phase, which would necessitate treatability studies. The work would then focus on a more thorough explanation of the effects on operable unit conditions or the performance of the remedial action technologies and process option of greatest interest. The probable effectiveness of performance will be evaluated using sensitivity analysis. Data quality objectives will be refined or developed, as needed for any treatability studies.

6.3 REMEDIAL ALTERNATIVES ANALYSIS

The detailed analysis of alternatives will follow the development and screening of alternatives and precede the actual selection of an interim remedy. The results of the detailed analysis will provide the basis for identifying a preferred alternative and preparing the proposed plan. The detailed analysis of alternatives will consist of the following components:

- Further definition of each alternative, if appropriate, with respect to the volumes or areas of contaminated media to be addressed, the technologies to be used, and any performance requirements associated with those technologies

- An assessment and a summary of each alternative against the evaluation criteria specified in EPA's interim final RI/FS guidance document (EPA 1988a)

- A comparative analysis among the alternatives to assess the remedial action.

A brief summary of the detailed analysis process can be found in EPA's interim final RI/FS guidance document (EPA 1988a).

6.3.1 Definition of Remedial Action Alternatives

The alternatives that remain after initial screening may need to be defined in more detail completely prior to the detailed analysis. During the detailed analysis, each alternative will be reviewed to determine whether additional definition is required to apply the evaluation criteria consistently and to develop order-of-magnitude cost estimates (-30 to +50%). Information developed to further define alternatives at this stage may include preliminary design calculations, process flow diagrams, sizing of key process components, preliminary layouts, and a discussion of limitations, assumptions, and uncertainties concerning each alternative. Information collected from treatability investigations, if conducted, will also be used to further define applicable alternatives.

6.3.2 Detailed Analysis of Alternatives

A detailed analysis will be conducted on the limited number of alternatives that represent viable hazardous waste management approaches. The detailed analysis will consist of an assessment of individual alternatives against the nine evaluation criteria listed by the EPA (1988a) and discussed in the subsections below. A comparative analysis will be performed and will focus on the relative performance of each alternative against the criteria. This will result in a summary of the tradeoffs among alternatives.

6.3.2.1 Overall Protection of Human Health and the Environment. Alternatives will be assessed as to whether they can adequately protect human health and the environment by eliminating, reducing, or controlling risks.

6.3.2.2 Compliance with Applicable or Relevant and Appropriate Requirements. Alternatives will be assessed as to whether they attain ARARs of federal and state environmental and public health laws or provide grounds for invoking one of the waivers under the proposed 40 CFR 300.430(f)(l)(ii)(c). Chemical-, location-, and action-specific ARARs will be evaluated.

6.3.2.3 Long-Term Effectiveness Analysis. Alternatives will be assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors will include the following:

- Magnitude of total residual risk remaining following implementation of a remedial alternative.

- The type, degree, and adequacy of long-term management required. This includes engineering controls, institutional controls, monitoring, and operation and maintenance.

- Long-term reliability of controls including uncertainties associated with land disposal of untreated hazardous waste and treatment residuals.

- The potential need for replacement of the remedy.

6.3.2.4 Analysis of Reduction in Waste Toxicity, Mobility, and Volume. The degree to which alternatives employ treatment that reduces toxicity, mobility, or volume will be assessed. Factors that will be considered include the following:

- Treatment processes the alternatives employ and materials they will treat

- Amount of hazardous waste that will be destroyed or treated

- Degree that toxicity, mobility, or volume will be expected to reduce

- The degree to which the treatment is irreversible

- Residuals that will remain following treatment

- The degree to which treatment reduces inherent hazards posed by principal threats at the site.

6.3.2.5 Short-Term Effectiveness Analysis. Short-term effectiveness of alternatives will be assessed considering the following:

- Short-term risks that might be posed to the community during implementation

- Potential impacts to workers during remedial action and the effectiveness and reliability of protective measures

- Potential environmental impacts encountered during the remedial action and the effectiveness and reliability of mitigative measures during implementation

- The time until protection is achieved.

6.3.2.6 Implementability Analysis. The ease or difficulty of implementing the alternatives will be assessed by considering the following:

- Degree of difficulty or uncertainty that is associated with construction and operation of the technology

- Expected operational reliability of the technologies the alternatives use and the ability to undertake additional action if required

- Ability and time required to obtain necessary approvals and permits from the agencies

- Available capacity and location that is needed for treatment, storage, and disposal services

- Availability of equipment and specialists that are needed

- Provisions ensuring necessary additional resources

- Timing of the availability of prospective technologies that may be under construction.

6.3.2.7 Cost Analysis. Capital, operation and maintenance costs will be assessed. These will be accumulated and compared using a net present value technique. The costs will be developed with an accuracy of +50 to -30%. If sufficient cost information is not available, bench-scale or pilot-scale treatability studies may be required. Accurate cost information will be necessary for the selection of the preferred alternative.

6.3.2.8 Analysis of State Acceptance. State of Washington concerns will be assessed. The areas of concern are usually with the proposed use of waivers for the selected alternative. Compliance of the solutions proposed with the state's Model Toxics Control Act (MTCA) will be described.

6.3.8.9 Analysis of Community Acceptance. Community attitudes toward the alternatives will be assessed. A complete assessment is not likely to be possible until comments have been received on the proposed action. One of the functions of the Community Relations Plan will be to involve the community in the process and keep them informed throughout.

6.3.3 Comparison of Remedial Action Alternatives

Once the alternatives have been individually assessed against the nine criteria provided in the National Contingency Plan, a comparative analysis will be conducted to evaluate each alternative in relation to each evaluation criterion. The key tradeoffs or concerns among alternatives will generally be based on the evaluations of short-term effectiveness; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; implementability; and cost. Overall protection and compliance with ARARs serve as a threshold determination in that they either will or will not be met.

The comparative analysis will include a narrative discussion describing the strengths and weaknesses of the alternatives relative to one another with respect to each criterion. The potential advantages in cost or performance of innovative technologies and the degree of uncertainty in their expected performance will also be discussed. The differences between all of the alternatives will be summarized in matrix form to facilitate direct comparisons. The information obtained by analyzing the alternatives individually against the nine criteria in Section 6.3.2 will be the basis for the matrix.

6.4 FOCUSED FEASIBILITY STUDY REPORT

The results of the initial development, screening, and analysis of alternatives will be combined into the FFS. The report will list the procedures for defining and evaluating the alternatives.

6.4.1 Report Preparation

The report will document the results of the identification and development of alternatives. Examples of the types of information to be included in the report are the following:

- Operable unit background summary with available project scoping information and LFI data, to include the nature and extent of contamination and contaminant fate and transport

- Confirmation of the operable unit environmental media of concern, including the rationale for continued inclusion in the FFS

- Identification of the RAOs for each environmental medium of concern

- Identification of the general response actions for each environmental medium of concern

- Identification of potential remediation technology types for each medium-specific general response action category

- Documentation of the assembly of general response actions, process options, and technologies into a range of remedial actions

- Identification of action-specific ARARs potentially pertinent to each alternative.

The following types of information pertinent to the screening phase will also be included:

- Definition of each alternative, including extent of remediation, area or volume of contaminated media, energy and area/space requirements of major technologies, process parameters, cleanup time frames, transportation distances, volume of remediation-derived waste and special considerations

- Screening evaluation summaries and comparisons between each alternative process

- Documentation of the screening process for determination of technical implementability of the technology

- Identification of potential technological process options for each technology type retained after screening

- Documentation of the process option evaluations and the selection of representative process options for each technology type.

The analysis of individual alternatives against the nine criteria will be presented as a narrative discussion accompanied by a summary matrix. The alternatives discussion will include data on technology components, quantity of hazardous materials handled, time required for implementation, process sizing, implementation requirements, and assumptions. The key ARARs for each alternative will also be incorporated into those discussions. The discussion will focus on how, and to what extent, the various factors within each of the criteria are addressed. A summary matrix will highlight the assessment of each alternative with respect to each of the criteria.

7.0 PROJECT SCHEDULE

The anticipated task schedules for the LFI activities are shown on Figure 7-1. These schedules should only be considered estimates and are based on numerous assumptions. Many variables exist that could affect the final schedule including resource commitments, availability of equipment and equipment downtime, changes in field activities after a review of the initial field results and federal, state, and public dispute resolutions.

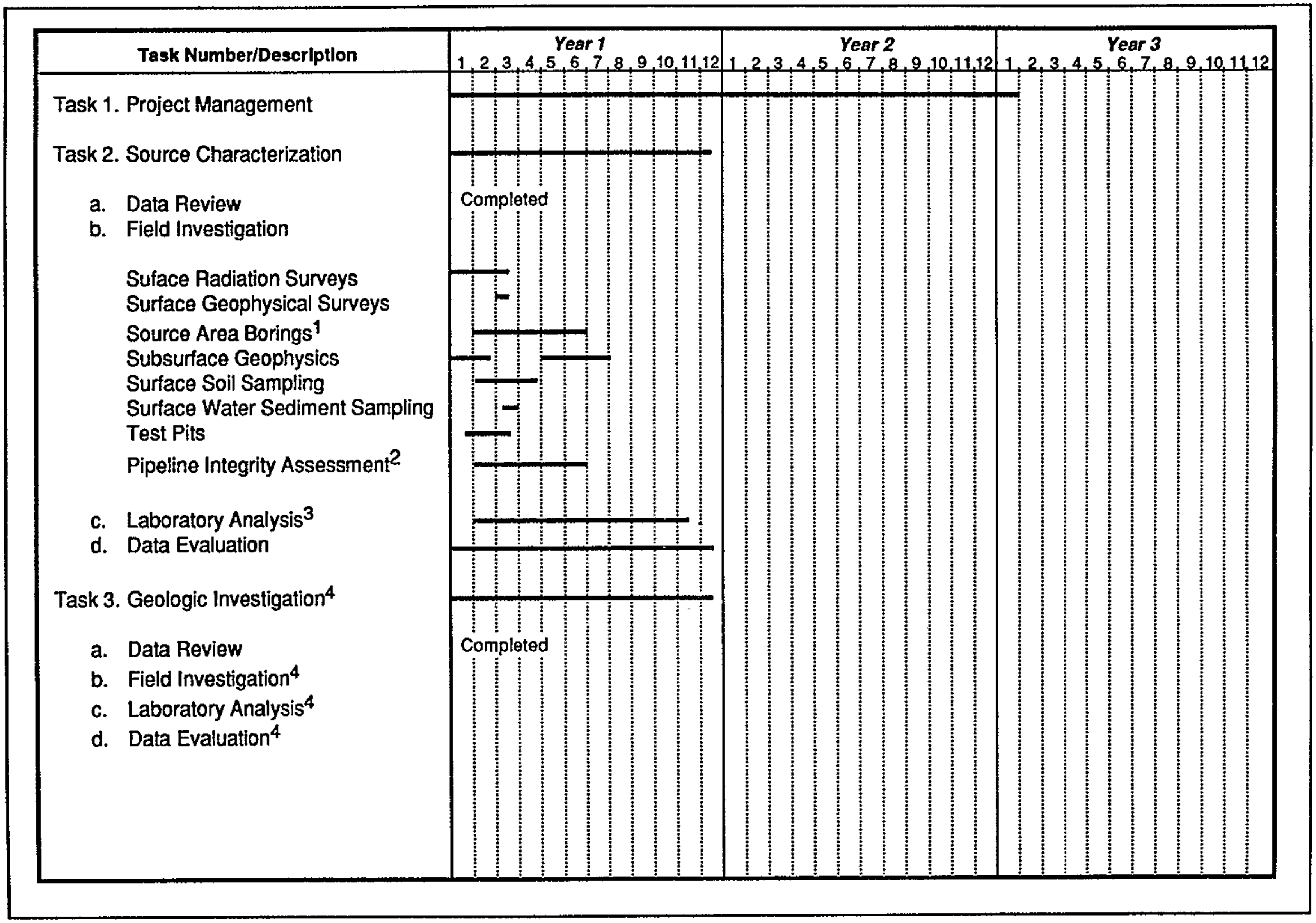


Figure 7-1. Schedule for LFI Activities.

9212501359

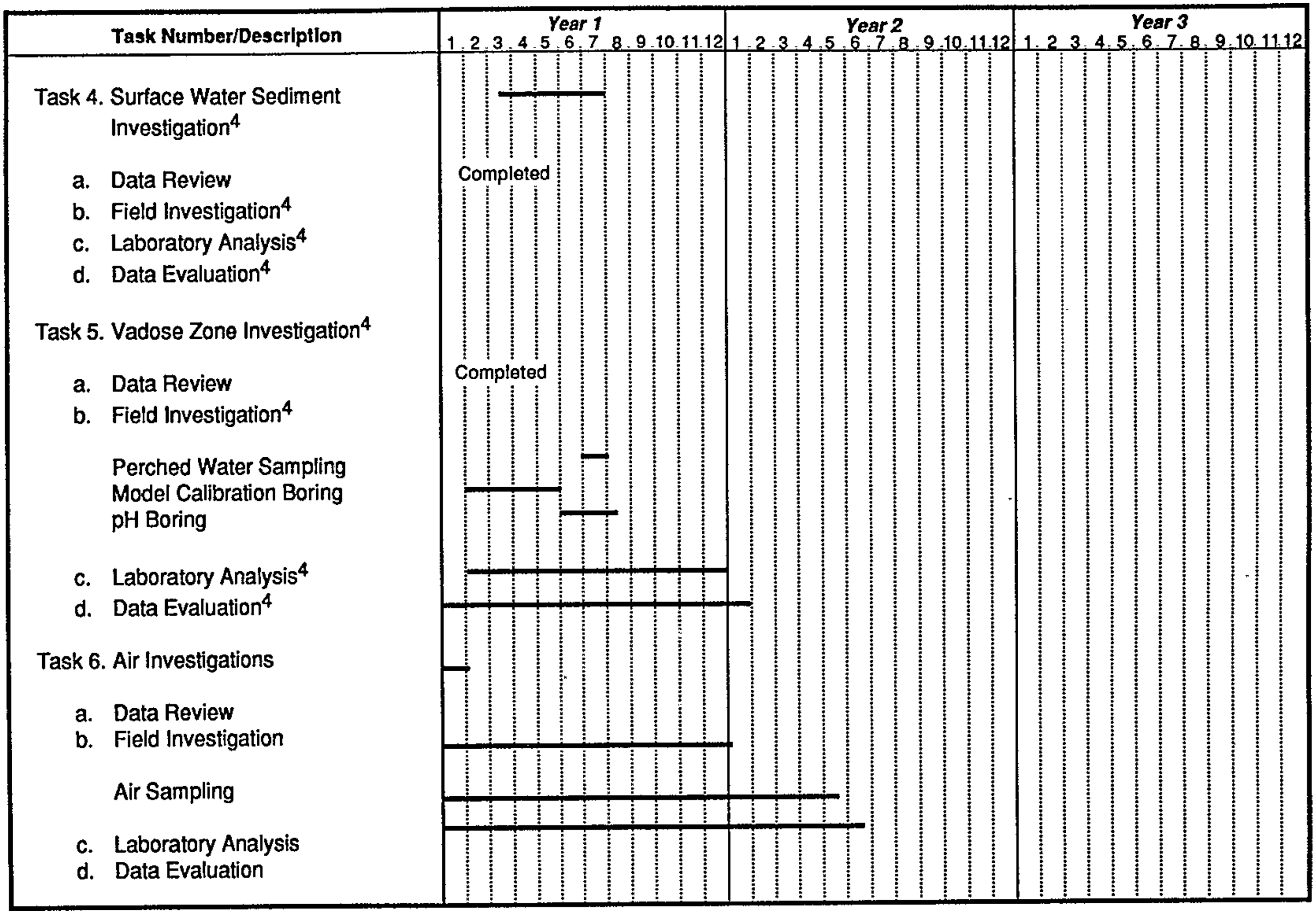
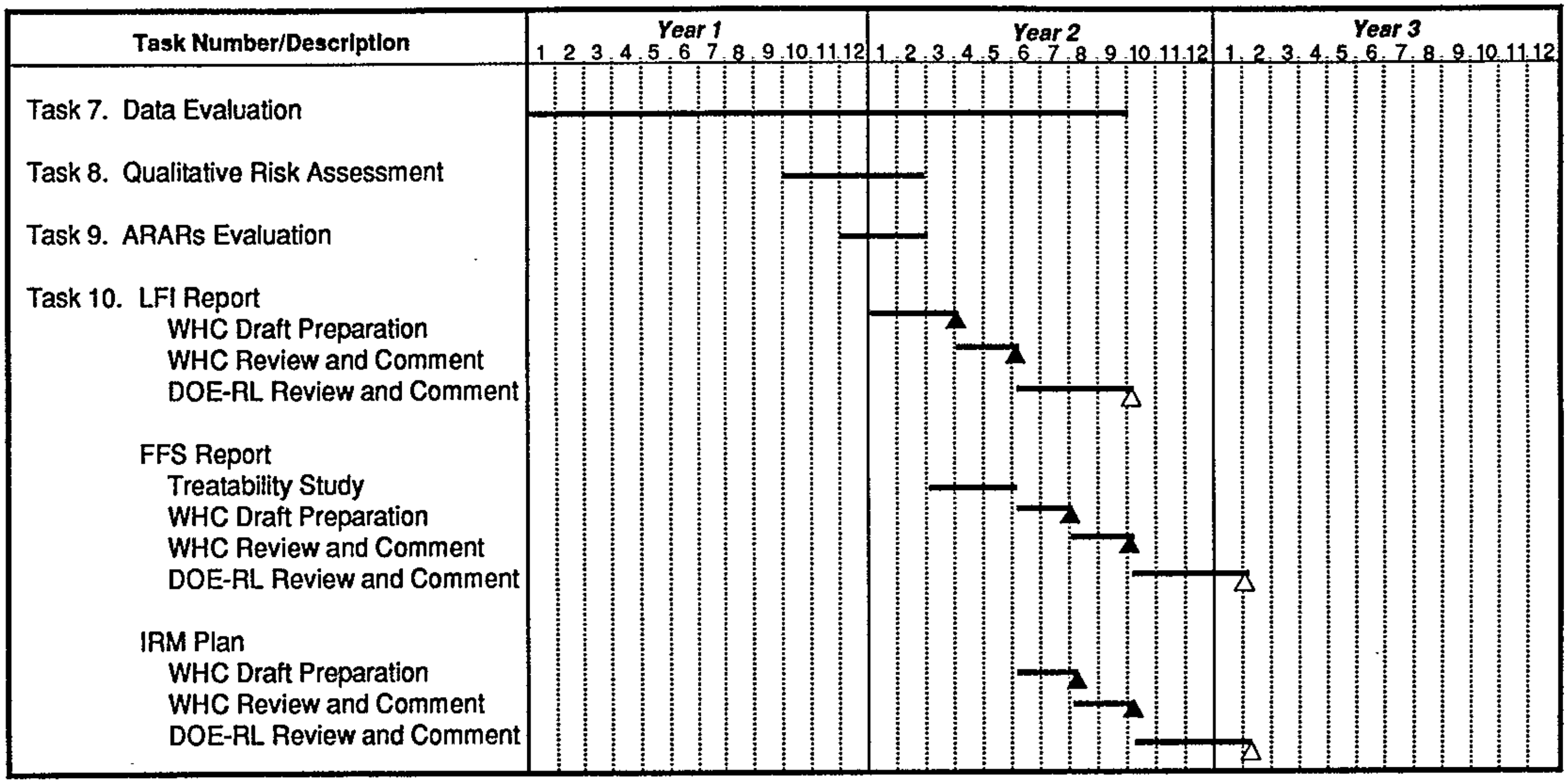


Figure 7-1. Schedule for LFI Activities (continued).

9 2 1 2 5 0 1 3 7 0



1. This assumes that seven holes are drilled. That drilling is conducted by 2 rigs making 3 ft/day through high-level intervals and 8 ft/day in low-level intervals. Each hole has approximately 2 weeks of mobilization/demobilization time.

2. This includes camera surveys, surface radiation surveys, and test pit sampling.

3. This assumes 105 days for data anlaysis, 21 days for data validation and 15 days for transferring data, for a total of 141 days.

4. These tasks include activities covered under source characterization (Task 2) and so the individual activities are not repeated here.

▲ Draft Report
△ Final Report

Figure 7-1. Schedule for LFI Activities (continued).

8.0 REFERENCES

ASTM, 1985, *High-Resolution Gamma-Ray Spectrometry of Water*, American Society for Testing and Materials.

Buckmaster, M.A. and A.M. Kaczor, 1992, *Drilling and Sampling Highly Radioactive Contaminated Soil at the 200-BP-1 Operable Unit,* Hanford Site, Richland, Washington, WHC-SA-1460-FP, Westinghouse Hanford Company, Richland, Washington.

CDM Federal Programs Corporation, 1987, *Data Quality Objectives for Remedial Response Activities: Volume 1, Development Process,* EPA-540/G-87/003A, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response and Office of Solid Waste and Emergency Response, Washington, D.C.

Cleveland, J.M., 1970, *The Chemistry of Plutonium,* Bordon and Breach, New York, p. 82.

DOE, 1991a, *Quality Assurance*, DOE Order 5700.6C, U.S. Department of Energy.

DOE, 1991b, *Expedited Response Action Proposal for 316-5 Process Trenches*, DOE/RL-91-11, U.S. Department of Energy—Richland Operations, Richland, Washington.

DOE/EML, 1990, *EML Procedures Manual*, U.S. Department of Energy.

DOE/RL, 1991, *Groundwater Model Development Plan in Support of Risk Assessment,* DOE/RL-91-62, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL, 1992a, *Hanford Site Past-Practice Investigation Strategy; Draft A,* DOE/RL-91-40, U.S. Department of Energy, Richland, Washington.

DOE/RL, 1992b, *Hanford Site Baseline Risk Assessment Methodology*, DOE/RL-91-45, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order*, Olympia, Washington.

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order, First Amendment*, 89-10, Rev. 1, Olympia, Washington.

Ecology, EPA, and DOE, 1992, *Hanford Federal Facility Agreement and Consent Order*, 1992 Annual Update (Amendment 3), Change Form M-17-91-05, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy.

Ecology, EPA, and DOE/RL, 1991, *Hanford Federal Facility Agreement and Consent Order Change Package*, May 16, 1991, Washington State Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1980a, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, U.S. Environmental Protection Agency.

EPA, 1980b, *Radionuclide Method for the Determination of Uranium in Soil and Air*, U.S. Environmental Protection Agency.

EPA, 1983, *Methods for Chemical Analysis of Water and Waste*, EPA-600/14-79-020, EMSL, U.S. Environmental Protection Agency.

EPA, 1984, *Eastern Environmental Radiation Facility RadioChemistry Procedures Manual*, U.S. Environmental Protection Agency.

EPA, 1986, *Test Methods for Evaluating Solid Wastes*, SW-846, Third Edition, U.S. Environmental Protection Agency/Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1988a, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA; Interim Final*, EPA-540/G-89/004, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1988b, *Superfund Exposure Assessment Manual*, EPA-540/1-88/001, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989a, *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual; Interim Final*, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989b, *Risk Assessment Guidance for Superfund: Volume II, Environmental Evaluation Manual; Interim Final*, EPA/540/1-89/001, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991, *EPA Region 10 Supplemental Risk Assessment Guidance for Superfund*, U.S. Environmental Protection Agency.

Huckfeldt, C.R., 1991, *Quarterly Environmental Radiological Survey Summary Second Quarter 1991-100, 200, 300 and 600 Areas*, WHC-SP-0665-1, Westinghouse Hanford Company, Richland, Washington.

Kasper, R.B., 1981, *Field Study of Plutonium Transport in the Vadose Zone*, RHO-SA-224, Rockwell Hanford Operations, Richland, Washington.

Last, G.V. and D.W. Duncan, 1980, *Radionuclide Distributions in Soils of the U-Pond Disposal System*, Rockwell Hanford Operations, Richland, Washington.

Lindsey, K.A., B.N. Bjornstad, and M.P. Connelly, 1991, *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Price, S.M., R.B. Kas per, M.K. Additon, R.M. Smith, and G.V. Last, 1979, *Distribution of Plutonium and Americium beneath the 216-Z-1A Crib: A Status Report*, RHO-ST-17, Rockwell Hanford Operations, Richland, Washington.

Smith, A.E., *Nuclear Reactivity Evaluations of 216-Z-9 Enclosed Trench*, ARH-2915, Atlantic Richfield Hanford Company, Richland, Washington, December 1973.

Stanley, T.W. and S.S. Verner, 1983, *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, EPA/600/4-83/004, U.S. Environmental Protection Agency, Office of Exploratory Research, Washington, D.C.

WHC, 1991a, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Waste Information Data System*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *200 Aggregate Area Management Study RLS Characterization Report: 200 West Area*, WHC-SD-EN-TI-021, Rev. 0, In Preparation, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

RLS GAMMA SPECTROMETER DATA

Westinghouse Hanford Company | **Internal Memo**

From: Geophysics Section 81232-92-006
Phone: 2-1200 G6-50
Date: April 1, 1992
Subject: Preliminary Evaluation of RLS Log Surveys for Boreholes 299-W19-11 and 299-W22-75

To: M. J. Galgoul H4-55

cc: D. B. Erb H4-55
J. W. Fassett H4-56
D. G. Horton H4-56
A. J. Knepp 4/2/92 H4-56
C. J. Koizumi G6-50
S. J. Trent H4-56
D. C. Weekes H5-29
C. D. Wittreich H4-55
200-UP-2 Project File
RKP File/LB

OBJECTIVE

This letter is in response to a request to examine two borehole surveys acquired by the spectral gamma logging system, RLS, at the 216-U-1 and 216-U-12 cribs. The purpose of the examination is to identify the man-made radionuclides present, the depth ranges of these radionuclides, and the relative concentrations. The data examined for this request were acquired in support of the 200 Aggregate Area Management Study (200 AAMS). The information provided in this letter is preliminary and subject to revision; further review and analysis of these data will be completed as part of the 200 AAMS borehole geophysics logging program and documented in topical reports to follow.

A brief explanation of the Equipment Configuration, Calibration, Acquisition Parameters, and Analysis Technique are included with the requested information as Appendix A. Complete details will be provided in the final 200 AAMS borehole geophysics topical reports.

Four man-made radionuclides were identified by the RLS surveys for the two boreholes. They are cesium-137, cobalt-60, uranium-235, and uranium-238.

The uranium isotopes were identified as not naturally occurring by the absence of gamma-ray peaks from daughters that are associated with natural uranium. The uranium-238 isotope is identified by the gamma-ray emitted from its second daughter, protactinium-234. Note that the low gamma-ray intensity of U-238 creates a high conversion factor from count rate to concentration. The uranium-235 isotope is identified by the presence of a gamma-ray at 185.7 keV. The energy of this gamma-ray, while identifiable in the spectra, is below the valid range of the detector efficiency function established from the November 1991 calibration data.

9 3 1 2 7 1 3 7 5

M. J. Galgoul
Page 2
April 1, 1992

81232-92-006

RESTRICTIONS

Use of the data included in this letter is limited by the following restrictions.

Uncertainties in the reported concentrations at 1 sigma (68% confidence interval) must be considered to be 50% of the computed concentrations. This uncertainty assumes the attenuation correction for the casing thickness is correct.

If the accumulated thickness of casing exceeds 0.40 inches and if grout or other material are present then the correction factor will be too small and the reported concentrations will be under-estimated.

Concentrations for radionuclides with gamma-ray energies less than 300 keV will not be estimated at this time. The detector efficiency function and casing correction factors vary at high rates below 300 keV. The calibration in November 1991 was concerned with gamma ray energies from 300 to 2620 keV.

Uranium-238 and uranium-235 are normally identified together. The concurrent detection of uranium-235 may be masked at the logging speed required for the 200 AAMS borehole geophysics logging program (see Appendix A) and the presence of cesium-137. The higher activity of cesium-137 and it higher energy gamma-ray (662 keV) can compromise the detection of radionuclides like uranium-235 with lower activity at lower gamma-ray energies (186 keV).

The depth error is less than two percent. Irregularities in the cable diameter prevent it from being properly seated into the sheave wheel at groove all time. As the cable rides up in the groove the effective diameter of the wheel increases and the depth to the detector is not precisely known. Further modifications will be made before the RLS is used to baseline or monitor radionuclides in the boreholes.

CRIB 216-U-1; BOREHOLE 299-W19-11

This borehole has two casing strings, 6 and 4 inch. There is grout between the two casings. The maximum casing correction thickness used by the program of 0.40 inches is less than the combined thickness of the two casings. The radionuclide concentrations will be under-estimated. Three man-made radionuclides were identified in the borehole. The radionuclides are Cs-137, Co-60, and U-238. The presence of uranium-235 at the same depths as uranium-238 while expected was not confirmed. Cesium-137 is present at the same depths as uranium-238 and may have prevented the detection of uranium-235 at the logging speed used for the screening mode. A plot of apparent concentrations versus depth is attached. The depth range and relative concentrations of each radionuclide follow.

9 2 1 2 9 1 3 7 5

Cesium-137:

Depths	1.5 to 10 ft	< 10 pCi/g
Depths	31 to 34 ft	4000 pCi/g max
Depths	34 to 82 ft	180 to < 10 pCi/gm

Cobalt-60:

Depths	31 to 50 ft	< 10 pCi/g

U-238:

Depths	33 to 51 ft	900 pCi/g max

CRIB 216-U-12; BOREHOLE 299-W22-75

This borehole has three casing strings, 8 inch to 160 feet, 6 inch to 220 feet, and 4 inch to 210 feet. There is grout between casings. The maximum casing thickness of 0.40 inches used by the program is less than the combined thickness of the three casings. The radionuclide concentrations will be under-estimated. Three man-made radionuclides were identified in the borehole. The radionuclides are Cs-137, U-235, and U-238. A plot of apparent concentrations versus depth is attached. The depth range and relative concentrations of each radionuclide follow.

Cesium-137:

Depths	16 to 58 ft	10 to 5000 pCi/g

U-235:

Depths	73 to 80 ft	Concentration not estimated

U-238:

Depths	17 to 20 ft	300 pCi/g max
Depths	43 to 80 ft	< 100 to 400 pCi/g

R. K. Price

R. K. Price, Principal Scientist
Geophysics Section

kbm

Attachment

9 2 1 2 3 1 0 3 7 7

APPENDIX A: Brief Explanation of Spectral-Gamma Survey Equipment

EQUIPMENT CONFIGURATION

The Radionuclide Logging System, RLS, is a logging system equipped to record high resolution gamma-ray spectra in boreholes. The down hole probe contains a high purity germanium solid state detector, HPGe. An analog signal is transmitted to the electronics modules in the truck for each gamma-ray detected. The voltage rise in the analog signal is proportional to the gamma-ray energy. A module in the truck digitizes each voltage amplitude and tallies the count into one of the 4000 channels of the multi-channel analyzer, MCA, so that the MCA channel number is proportional to the gamma-ray energy. The system is configured to record gamma-rays with energies up to about 3000 keV. The range of the gamma-ray energies the system has detected through the steel casing in the boreholes is from 59 to 2615 keV. A standard method of identifying the quality of a germanium system is by quoting the full width at half maximum (FWHM), resolution of the 1332.5 keV gamma-ray of Cobalt-60. The FWHM through the 600 feet of logging cable is 2.1 keV.

A computer in the truck controls the logging operation. The computer functions include:

- Start and stop MCA gamma-ray counting,
- Transfer MCA data to the computer memory,
- Monitor detector depth,
- Control winch speed, and
- Store MCA data, detector depth and well information on disk.

CALIBRATION

The RLS was calibrated at the DOE calibration facilities in Grand Junction, Colorado during November 1991. The calibration permits the count rate from the gamma-ray photo peaks to be converted to radionuclide concentration. The radionuclide concentrations in the calibration models are traceable to national standards. The calibration configuration is for 4.5 inch boreholes with no casing and no liquid in the borehole. Calibration is conducted in models that appear to be infinite homogenous media to borehole detectors. Measurements were also acquired in two models with several hole sizes to verify that the larger air filled holes do not affect the counts observed in the gamma-ray photo peaks. Several steel casings of various thicknesses were used to quantify the decrease in signal intensity and permit correction factors to be established. No casing measurements with multiple casing thicknesses were performed during this trip.

Analysis of the calibration measurements has been completed and a detector efficiency function was computed for gamma-ray energies between 186 to 2615 keV. The units of radionuclide concentration are pico-Curies per gram.

ACQUISITION PARAMETERS

The borehole survey acquisition parameters determine the depth interval of each spectra, the logging mode, and the counting time for each spectrum. The objective of the 200 AAMS surveys are for screening (ie. identify radionuclide species determine "relative" concentrations and estimate depth ranges). The absolute radionuclide concentrations are of secondary importance. The "Fixed Velocity" logging mode and logging speed of 40 feet per hour were selected. The standard sample increment of 0.5-foot is maintained. System overhead of starting and stopping the MCA module, transferring the data to the disk drive and displaying the spectra on the truck monitor have a direct impact on the counting time available in each depth interval. The count time at each 0.5-foot depth interval is about 30 seconds.

The zero depth of the borehole survey is established at ground level. The detector depth is determined by the rotation of the sheave wheel suspended above the borehole through which the cable passes.

ANALYSIS TECHNIQUES

Analysis of the borehole spectra involves several steps. Many must be performed on each spectra. The steps are given below.

Verify the energy calibration coefficients that relate the gamma-ray energy to the MCA channel number. This is performed by locating common peaks in the spectra and recomputing the coefficients. The common gamma-rays from the natural radionuclides of potassium, uranium, and thorium are used.

Locate all gamma-ray photo peaks present in the spectra and determine the net counts recorded in each peak, convert the net counts to count rate. The parameters for locating peaks are set such that no gamma-ray photo peak should be missed. However, this will occasionally permit some channels with statistically elevated counts to be identified as a possible gamma-ray peak.

Identify the radionuclides associated with the gamma-ray peaks. Those peaks which are not identified and have counting uncertainties less than 50 percent are recorded in a detail analysis report and summarized in a "NonMatch" gamma-ray peak table.

Determine the casing attenuation factor for each gamma-ray photo peak. The casing-correction factor varies as a function of gamma-ray energy. Correct the gamma-ray count rate for the casing attenuation. The casing attenuation factor has been established for casing thicknesses up to 0.40 inches. Measurements within multiple casings with accumulated thicknesses greater than 0.40 inches will yield radionuclide concentrations that are under-estimated.

Retrieve from the radionuclide identification table the gamma-ray intensity factor which indicates the number of gamma-rays emitted per decay, expressed as a percentage.

Combine the gamma intensity factor with the detector efficiency function to establish the conversion factor from count rate to radionuclide concentrations. Compute the apparent radionuclide concentrations. The gamma intensity factors for radionuclides that have been identified by the RLS at Hanford vary from 0.20 to 99.99 percent.

The count rate in the photo peak was converted to concentrations in pico-curies per gram. The conversion factor for the primary gamma-ray photo peaks of each radionuclide is tabulated below. The conversion factor for U-235 is not quoted. The U-235 gamma-ray at 185.7 keV, while identifiable in the spectra, is below the valid range of the November 1991 calibration data.

Nuclide Isotope	Gamma-ray Energy (keV)	Gamma-ray Intensity (pct)	Conversion Factor pCi/gm per cps
Cs-137	661.6	85.00	1.05
Co-60	1332.5	99.98	1.11
U-238	1001.0	0.59	172.
U-235	185.7	54.00	---

ATTACHMENT 1

QUALITY ASSURANCE PROJECT PLAN

QUALITY ASSURANCE PROJECT PLAN FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY OF THE 200-UP-2 OPERABLE UNIT

Westinghouse Hanford Company
Environmental Engineering and Technology Function
Richland, Washington

Approved by:

U.S. EPA Unit Manager	______________	Date ________
U.S. EPA QA Officer	______________	Date ________
Washington State Department of Ecology Unit Manager	______________	Date ________
Washington State Department of Ecology QA Officer	______________	Date ________
U.S. DOE Unit Manager	______________	Date ________
U.S. DOE QA Officer	______________	Date ________
Westinghouse Hanford/EE&T Technical Lead	______________	Date ________
Westinghouse Hanford QA Officer	______________	Date ________

This page intentionally left blank

CONTENTS

CONTENTS (cont.)

TABLES:

ACRONYMS

ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRQL	Contractually Required Quantitation Limit
DOE	Department of Energy
DQOs	data quality objective
EE&T	Environmental Engineering and Technology
EII	Environmental Investigations Instruction
EPA	Environmental Protection Agency
FS	feasibility study
GC	gas chromatography
HEIS	Hanford Environmental Information System
IMO	Information Management Overview
LFI	limited field investigation
MRP	Management Requirements and Procedures
OSM	Office of Sample Management
PQL	Practical Quantitation Limit
QA	quality assurance
QAPI	Quality Assurance Program Index
QAPjP	Quality Assurance Project Plan
QC	quality control
QI	Quality Instruction
QR	Quality Requirement
RI	remedial investigation
RPD	relative percent difference
TCL	target compound list
VOA	volatile organics analysis

GLOSSARY

Accuracy: Accuracy may be interpreted as the measure of the bias in a system. The factors that influence the accuracy of the data include; sample procedures; field conditions, sample preservation, sample matrix, instrument calibration and analysis technique. Sampling accuracy is normally assessed through the evaluation of matrix-spiked samples and reference samples (see glossary entry).

Audit: For the purposes of environmental investigations, audits are considered to be systematic checks to verify the quality of operation of one or more elements of the total measurement system. In this sense, audits may be of two types: (1) performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained in a measurement system, or (2) system audits, involving a qualitative onsite evaluation of laboratories or other organizational elements of the measurement system for compliance with established quality assurance program and procedure requirements. For environmental investigations at the Hanford Site, performance audit requirements are fulfilled by periodic submittal of blind samples to the primary laboratory, or the analysis of split samples by an independent laboratory. System audit requirements are implemented through the use of standard surveillance procedures.

Bias: Bias represents a systematic error that contributes to the difference between a population mean of a set of measurements and an accepted reference or true value.

Blind Sample: A blind sample refers to any type of sample routed to the primary laboratory for performance audit purposes, relative to a particular sample matrix and analytical method. Blind samples are not specifically identified as such to the laboratory. They may be made from traceable standards, or may consist of sample material spiked with a known concentration of a known compound. See the glossary entry for Audit.

Comparability: For the purposes of environmental investigations, comparability is an expression of the relative confidence with which one data set may be compared with another.

Completeness: For the purposes of environmental investigations, completeness may be interpreted as a measure of the amount of valid data obtained compared to the total data expected under correct normal conditions.

Deviation: For the purposes of environmental investigations, deviation refers to an approved departure from established criteria that may be required as a result of unforeseen field situations or that may be required to correct ambiguities in procedures that may arise in practical applications.

Equipment Blanks: Equipment blanks consist of pure deionized, distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. They are used to verify the adequacy of sampling equipment decontamination procedures, and are normally collected at the same frequency as field duplicate samples.

Field Blanks: Field blanks for water analyses consist of pure deionized, distilled water, transferred to a sample container at the site and preserved with the reagent specified for the analyses of interest. They are used to check for possible contamination originating with the reagent or the sampling environment, and are normally collected at the same frequency as field duplicate samples.

Field Duplicate Sample: Field duplicate samples are samples retrieved from the same sampling location using the same equipment and sampling technique, placed in separate, identically prepared and preserved containers, and analyzed independently. Field duplicate samples are generally used to verify the repeatability or reproducibility of analytical data, and are normally analyzed with each analytical batch or every 20 samples, whichever is greater.

Matrix-Spiked Samples: Matrix-spiked samples are a type of laboratory quality control sample. They are prepared by splitting a sample received from the field into two homogenous aliquots (i.e., replicate samples) and adding a known quantity of a representative analyte of interest to one aliquot in order to calculate the percentage of recovery of that analyte.

Nonconformance: A nonconformance is a deficiency in the characteristic, documentation, or procedure that renders the quality of material, equipment, services, or activities unacceptable or indeterminate. When the deficiency is of a minor nature, does not effect a permanent or significant change in quality if it is not corrected, and can be brought into conformance with immediate corrective action, it shall not be categorized as a nonconformance. If the nature of the condition is such that it cannot be immediately and satisfactorily corrected, however, it shall be documented in compliance with approved procedures and brought to the attention of management for disposition and appropriate corrective action.

Precision: Precision is a measure of the repeatability or reproducibility of specific measurements under a given set of conditions. The relative percent difference (RPD) is used to assess the precision of the sampling and analytical method. The RPD is a quantitative measure of the variability. Specifically, precision is a quantitative measure of the variability of a group of measurements compared to their average value. Precision is normally expressed in terms of standard deviation, but may also be expressed as the coefficient of variation (i.e., relative standard deviation) and range (i.e., maximum value minus minimum value). Precision is assessed by means of duplicate/replicate sample analysis.

Quality Assurance: For the purposes of environmental investigations, QA refers to the total integrated quality planning, quality control, quality assessment and corrective action activities that collectively ensure that the data from monitoring and analysis meets all end user requirements and/or the intended end use of the data.

Quality Assurance Project Plan: The QAPjP is an orderly assembly of management policies, project objectives, methods and procedures that defines how data of known quality will be produced for a particular project or investigation.

Quality Control: For the purposes of environmental investigations, QC refers to the routine application of procedures and defined methods to the performance of sampling, measurement and analytical processes.

Range: Range refers to the difference between the largest and smallest reported values in a sample, and is a statistic for describing the spread in a set of data.

Reference Samples: Reference samples are a type of laboratory quality control sample prepared from an independent, traceable standard at a concentration other than that used for analytical equipment calibration, but within the calibration range. Such reference samples are required for every analytical batch or every 20 samples, whichever is greater.

Replicate Sample: Replicate samples are two aliquots removed from the same sample container in the laboratory and analyzed independently.

Representativeness: For the purposes of environmental investigations, representativeness may be interpreted as the degree to which data accurately and precisely represent a characteristic of a population parameter, variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of a sampling program.

Split Sample: A split sample is produced through homogenizing a field sample and separating the sample material into two equal aliquots. Field split samples are usually routed to separate laboratories for independent analysis, generally for purposes of auditing the performance of the primary laboratory relative to a particular sample matrix and analytical method. See the glossary entry for Audit. In the laboratory, samples are generally split to create matrix-spiked samples (see the glossary entry).

VOA Trip Blanks: Volatile Organics Analysis (VOA) trip blanks are a type of field quality control sample, consisting of pure deionized distilled water in a clean, sealed sample container, accompanying each batch of containers shipped to the sampling site and returned unopened to the laboratory. Trip blanks are used to identify any possible contamination originating from container preparation methods, shipment, handling, storage or site conditions.

Validation: For the purposes of environmental investigations, validation refers to a systematic process of reviewing data against a set of criteria to provide assurance that the data are acceptable for their intended use. Validation methods may include review of verification activities, editing, screening, cross-checking or technical review.

Verification: For the purposes of environmental investigations, verification refers to the process of determining whether procedures, processes, data or documentation conform to specified requirements. Verification activities may include inspections, audits, surveillance or technical review.

1.0 PROJECT DESCRIPTION

1.1 PROJECT OBJECTIVE

The purpose of this Quality Assurance Project Plan (QAPjP) is to ensure the objectives described in Section 1.5 of the work plan will be met. Data resulting from this investigation will be evaluated to determine the most feasible options for additional investigation, remediation, or closure.

1.2 BACKGROUND INFORMATION

The 200-UP-2 Operable Unit is located within the 200 Areas of the Hanford Site, shown in Figure 1-1 of the work plan. The waste management units which will be studied during the 200-UP-2 Operable Unit Limited Field Investigation (LFI) are:

- 5 cribs
- 4 french drains
- 1 pond
- 1 trench
- 1 reverse well
- 4 ditches
- 1 settling tank
- 1 retention basin.

Detailed background information regarding the history and current use of the operable unit is provided in Section 2.0 of the work plan.

1.3 QUALITY ASSURANCE PROJECT PLAN APPLICABILITY AND RELATIONSHIP TO THE WESTINGHOUSE HANFORD QUALITY ASSURANCE PROGRAM

This QAPjP applies specifically to the field activities and laboratory analyses performed as part of the LFI for the 200-UP-2 Operable Unit. It is prepared in compliance with the requirements of the Westinghouse Hanford *Environmental Engineering, Technology and Permitting Function Quality Assurance Program Plan* (WHC 1990a). This plan describes the means selected to implement the overall quality assurance (QA) program requirements defined by the Westinghouse Hanford *Quality Assurance Manual* (WHC 1992a), as applicable to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation/feasibility study (RI/FS) environmental investigations. The QAPjP is subject to mandatory review and revision prior to use on any subsequent phases of the investigation. Distribution and revision control procedures applicable to the QAPjP and work plan shall be in compliance with Quality Requirement (QR) 6.0, *Document Control* (WHC 1992a), and Quality Instruction (QI) 6.1, *Quality Assurance Document Control* (WHC 1992a). Interim changes to this QAPjP or the work plan shall be documented, reviewed, and approved as required by Section 6 of Environmental Investigations Instruction (EII) 1.9, "Work Plan Review" (WHC 1992b), and shall be documented in monthly unit managers' meeting minutes. The QAPjP distribution shall routinely include all review/approval personnel indicated on the title page of the document and all other individuals designated by the Westinghouse Hanford Technical Lead for each investigation. All plans and procedures referenced in the QAPjP are available for regulatory review on request by the direction of the Technical Lead.

1.4 SCHEDULE OF ACTIVITIES

Five separate investigations will be conducted in the 200-UP-2 Operable Unit, including geological, surface water and sediment, groundwater, and ecological investigations, as well as an investigation made up of other miscellaneous tasks. More detailed discussions of individual tasks are contained in Section 5.0 of the work plan. Procedures directly applicable to the tasks described here are discussed in Section 4.0 of the QAPjP.

The field-related tasks to be conducted are:

- Task 2: Source characterization
- Task 3: Geologic Investigation
- Task 4: Surface Water/Sediment Investigation

- Task 5: Vadose Zone Investigation.

- Task 6: Air Investigation.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 TECHNICAL LEAD RESPONSIBILITIES

The Environmental Engineering and Technology (EE&T) function of Westinghouse Hanford has primary responsibilities for conducting this investigation. Organizational charts are included in the Project Management Plan of the AAMSR that define personnel assignments and individual Westinghouse Hanford field team structures applicable to the tasks included in the investigations.

External participant contractors or subcontractors shall be evaluated and selected for certain portions of task activities at the direction of the Technical Lead in compliance with the following procedures in the Westinghouse Hanford *Quality Assurance Manual* (WHC 1992a) QI 4.1, "Procurement Document Control"; QI 4.2, "External Services Control"; QR 7.0 "Control of Purchased Items and Services"; QI 7.1, "Procurement Planning and Control", and QI 7.2, "Supplier Evaluation." Major participant contractor and subcontractor resources are discussed in Section 7.0 of the work plan. All contractor QA plans and field and laboratory procedures shall be approved by Westinghouse Hanford prior to use and shall be made available for regulatory review at the direction of the Westinghouse Hanford Technical Lead.

2.2 ANALYTICAL LABORATORIES

Regardless of the radiation levels observed during field screening, all samples shall be routed to the Westinghouse Hanford 222-S Laboratory for total activity counts and isotopic identification in compliance with the *Radiation Protection Manual* (WHC 1988a), prior to shipment to the analytical laboratory.

Packaging and shipping requirements shall be selected on the basis of total activity values and the preservation requirements applicable to the parameters of interest, as described in EII 5.11 "Sample Packaging and Shipping" (WHC 1992b). All analyses shall be coordinated through the Westinghouse Hanford Office of Sample Management (OSM) and shall be performed in compliance with Westinghouse Hanford-approved laboratory QA plans and analytical procedures; all analytical laboratories shall be subject to the surveillance controls described by QI 10.4 "Surveillance" (WHC 1992a). For subcontractors or participant contractors, applicable quality requirements shall be invoked as part of the approved procurement documentation or work order; see Section 4.2. Services of alternate qualified laboratories shall be procured for radioactive sample analysis if onsite laboratory capacity is not available, and/or for the performance of split sample analysis at the Technical

Lead's discretion. If such an option is selected, the laboratory QA plan and applicable analytical procedures from the alternate laboratory shall be approved by Westinghouse Hanford before their use, as noted in Section 4.2.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENTS

The rationale for establishing Data Quality Objectives (DQOs) and data needs for this investigation is presented in Section 4.1 of the work plan. Analytical procedures are discussed in Section 7.0 of the QAPjP and include both standard and non-standard procedures. Standard Environmental Protection Agency (EPA) methods selected from *Test Methods for Evaluating Solid Waste* (EPA 1986) shall be used for analytical analysis of metals and organics as shown in Table QAPjP-1. Standard EPA and Department of Energy (DOE) methods shall also be used for analysis of the radiological parameters. Analysis of the soil physical properties will require both standard American Society for Testing and Materials (ASTM) methods and non-standard methods as described in Sections 4.0 and 5.0 of the work plan. Methods for soil analysis have been published by the American Society of Agronomy, and include *Methods of Soil Analysis: Part 1*, (Klute 1986) and *Methods for Soil Analysis: Part 2 - Chemical and Microbiological Properties*, (Page et al. 1982). These reference methods will form the basis of project-specific test procedures which shall be developed, reviewed, approved, and issued in compliance with QR 11.0, "Test Control" (WHC 1992a).

All of the analytical parameters selected for the soil and water sampling phase of this investigation are listed in Table QAPjP-1, and cross-referenced to analytical method requirements and maximum quantitation limit or detection limit values and maximum acceptable ranges for precision and accuracy in soil matrices. Where Practical Quantitation Limits (PQLs) are not defined for a particular parameter listed in Table QAPjP-1, Contractually Required Quantitation Limits (CRQLs) are provided that represent maximum values that can be reliably achieved by analytical laboratories under normal conditions. Precision and accuracy values are provided for all chemical and radiological parameters that also represent maximum values that can be reliably achieved by analytical laboratories under normal conditions. The requirements of Table QAPjP-1 shall be considered a minimum performance standard, and shall be incorporated into the agreements for services established with individual Westinghouse Hanford, participant contractor, or subcontractor analytical laboratories.

Goals for data representativeness are addressed qualitatively by the specification of sampling depths and intervals in Section 4.2 of the work plan. Sampling locations are specified in Section 5.0 or work orders issued to the subcontractors or participating contractors responsible for conducting sampling activities. Objectives for the completeness of this investigation shall require that contractually or procedurally established requirements for precision and accuracy be met for at least 90% of the total number of requested determinations. Failure to meet this criterion shall be documented and evaluated in the validation process described in Section 8.0; corrective action shall be taken as warranted, as described in Section 13.0. Approved analytical procedures shall require the use of the reporting techniques and units specified in the EPA reference methods in Table QAPjP-1 to facilitate the comparability of data sets in terms of precision and accuracy.

4.0 SAMPLING PROCEDURES

4.1 WESTINGHOUSE HANFORD PROCEDURES

The Westinghouse Hanford procedures that will be used to support the closure plan have been selected from the quality assurance program index (QAPI) included in the *Westinghouse Hanford, Environmental Engineering, Technology and Permitting Function Quality Assurance Program Plan* (WCP-EP-0330). Selected Procedures include Environmental Investigation and Instructions (EIIs) from the *Environmental Investigations and Site Characterization Manual* (WHC 1992b), and quality requirements (QRs) and quality instructions (QIs) from the *Westinghouse Hanford Quality Assurance Manual* (WHC 1992a). Procedure approval, revision, and distribution control requirements applicable to EEIs are addressed in EEI 1.2, "Preparation and Revision of Environmental Investigation Instructions" (WHC 1992b); requirements applicable to QIs and QRs are addressed in QR 5.0, "Instructions, Procedures, and Drawings"; QI 5.1, "Preparation of Quality Assurance Document Control" (WHC 1992a). Other procedures applicable to the preparation, review, and revision of OSM and other Hanford analytical laboratory procedures shall be defined in the various procedures and manuals identified in the *Environmental Engineering, Technology and Permitting Function Quality Assurance Program Plan* (WHC-EP-0330) under criteria 5.00 and 6.00. All procedures are available for regulatory review on request at the direction of the Technical Lead.

4.2 PARTICIPANT CONTRACTOR/SUBCONTRACTOR PROCEDURES

As previously noted in Section 2.1, participant contractor and/or subcontractor services shall be procured under the applicable requirements of QR 4.0, "Procurement Document Control", QR 7.0, "Control of Purchased Items and Services" (WHC 1992a), and other procedures as identified under criteria 4 and 7 of the QAPI included in the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a). Submittal of procedures for Westinghouse Hanford review and approval before use shall be included in the procurement document or work order, as applicable, when such services require procedural controls. Analytical laboratories shall be required to submit the current version of their internal QA program plans, and analytical procedures for review and approval by qualified personnel from the Westinghouse Hanford OSM, or other qualified personnel, as directed by the Technical Lead.

All reviewers shall be qualified under the requirements of EII 1.7, "Indoctrination, Training and Qualification" (WHC 1992b) or the *Management Requirements and Procedures Manual* (MRP), 4.2 "Employment Personnel and Placement" (WHC 1988b), as applicable.

All participant contractor or subcontractor procedures, plans and/or manuals shall be retained as project records in compliance with Section 9 of the *Document Control and Records Management Manual* (WHC 1988c).

4.3 PROCEDURE CHANGES

Should deviations from established EIIs be required to accommodate unforeseen field situations, they may be authorized by the field team leader in accordance with the requirements specified in EII 1.4, "Instruction Change Authorizations" (WHC 1992b). Documentation, review and disposition of instruction change authorization forms shall be as defined by EII 1.4. Other types of procedure change requests shall be documented as required by QR 6.0, "Document Control" (WHC 1992a) or other procedures as identified under criterion 6 of the QAPI included in the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a). To deviate from established radiation monitoring procedures, a field change request shall be completed in accordance with the *Occupational Health Physics Practices Manual* (WHC 1992c) and approved by the Occupational Health and Safety Manager assigned to this investigation.

4.4 SAMPLING PROCEDURES

4.4.1 Sample Acquisition

All soil and sludge sampling shall be performed in accordance with EII 5.2, "Soil and Sediment Sampling" (WHC 1992b). Perched water sampling shall be performed in compliance with EII 5.8, "Groundwater Sampling" (WHC 1992b); soil gas sampling shall be performed in compliance with EII 5.9, "Soil-Gas Sampling" (WHC 1992b). Surface water and other specialized types of sampling shall be in compliance with EIIs developed in accordance with EII 1.2, "Preparation and Revision of Environmental Investigations Instructions" (WHC 1992b), or Westinghouse Hanford-approved participant contractor or subcontractor procedures. All drilling activities shall be in compliance with EII 6.7, "Resource Protection Well and Test Borehole Drilling" (WHC 1992b). All boreholes shall be logged in compliance with EII 9.1, "Geologic Logging" (WHC 1992b). Sampling procedure applicability to individual project tasks is shown in Table 5-2 of the work plan. Sampling depths and intervals are identified in Section 4.2 of the work plan. Sample locations will be detailed in the statements of work or work orders issued to the responsible subcontractors or participating contractors. Documentation requirements are contained within individual EIIs and the Information Management Overview (IMO).

Sample container types, preservation requirements, and special handling requirements are defined in EII 5.2, "Soil and Sediment Sampling" (WHC 1992b). The analytical laboratory may require the use of proprietary sample analysis request forms or have specific requirements for samples. Written instructions on these requirements shall be provided by a description of work prior to conducting sampling activities.

4.4.2 Radiological Testing

The Westinghouse Hanford Field Sampling Team Leader and the assigned Health Physics Technician shall be responsible for screening all samples collected to determine proper handling protocols, in compliance with the Radiation Work Permit established for the sampling site. At a minimum, all sampler assemblies shall be screened for alpha and beta gamma radiation with field instrumentation in compliance with EII 3.4, "Field Screening." Samplers that do not exhibit radiation above background levels may be opened, and sample materials extracted and placed in appropriate containers in compliance with EII 5.2, "Soil and Sediment Sampling" (WHC 1992b). Any samples exhibiting radiation levels during field screening that are above background but less than 300mR/h shall be routed to an unshielded glovebox established at the field site for extraction of sample materials and placement in appropriate sample containers. Samplers exhibiting radiation greater than 300 mR/h shall be routed to a shielded glovebox, also established at the field site, prior to sample material extraction. Samplers exhibiting radiation levels greater than or equal to 1 R/h shall be sealed in plastic bags and routed to the Westinghouse Hanford 222-S Laboratory for total activity counts and isotopic identification in compliance with the *Radiation Protection Manual* (WHC 1988a) prior to shipment to the analytical laboratory.

4.4.3 Geologic and Geophysical Testing

Borehole logging shall be conducted concurrent with the drilling operations. A well sheet summary shall be completed for the entire length of the boring activity for each day. The summary sheet shall contain the geologic and construction information listed in EII 9.1, "Geologic Logging" (WHC 1992b).

4.5 OTHER INVESTIGATIVE AND SUPPORTING PROCEDURES

Procedures that will be required in this investigation are identified in the text of the work plan and in Table QAPjP-2. Documentation requirements shall be addressed within individual procedures and/or the IMO as appropriate. Analytical procedures required for this investigation are listed in Table QAPjP-1. All computer software models developed for this investigation shall be documented and verified to comply with procedures identified under criterion three of the QAPI included in the program plan (WHC 1990a).

4.6 RECORDS

Records requirements for sample collection include (but are not limited to) field notebooks, chain-of-custody records, sample analysis request forms, geologic logs, scintillation logs, and other documents. All records shall be managed in compliance with EII 1.6, "Records Management" (WHC 1992b) and the *Document Control and Records Management Manual* (WHC 1988c).

5.0 SAMPLE CUSTODY

5.1 CHAIN-OF-CUSTODY PROCEDURES

All samples obtained during the course of this investigation shall be controlled as required by EII 5.1, "Chain of Custody" (WHC 1992b), from the point of origin to the analytical laboratory. Samples are to be prepared, packaged, and transported to the laboratory in accordance with EII 5.11, "Sample Packaging and Shipping" (WHC 1992b). Laboratory chain-of-custody procedures shall be reviewed and approved in compliance with the requirements of Section 4.1 of this QAPjP, and shall ensure the maintenance of sample integrity and identification throughout the analytical process. At the direction of the Technical Lead, requirements for the return of residual sample materials after completion of analysis shall be defined in accordance with procedures described in the procurement documentation to subcontractor or participant contractor laboratories. Chain-of-custody forms shall be initiated for returned residual samples as required by the approved procedures applicable within the laboratory. All analytical results shall be controlled as permanent project quality records as required by EII 14.1, "Analytical Laboratory Data Management" (WHC 1992b) and Section 9 of the *Document Control and Records Management Manual* (WHC 1988c).

6.0 CALIBRATION PROCEDURES

The procedural control for the use, handling, maintenance, and calibration of health and safety monitoring instruments used in Resource Conservation and Recovery Act (RCRA) and CERCLA investigations shall be done in accordance with EII 3.2 "Health and Safety Monitoring Instruments" (WHC 1992b). Calibration of all Westinghouse Hanford measuring and test equipment, whether in existing inventory or procured for this investigation, shall be controlled as required by QR 12.0, "Control of Measuring and Test Equipment" (WHC 1992a), and other procedures as identified under criterion 12 of the QAPI included in the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a). The daily checks and calibration procedures for instruments used to measure radiological and chemical constituents in soil during drilling activities are provided in EII.3.4, "Field Screening" (WHC 1992b). The instruments used for geophysical borehole logging shall be calibrated and operated in accordance with EII 11.1 "Geophysical Logging" (WHC 1992b) and *Base Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System* (WHC 1992d). All calibration of analytical laboratory equipment shall be as defined by applicable standard analytical methods, and are subject to Westinghouse Hanford review and approval prior to use.

7.0 ANALYTICAL PROCEDURES

Analytical methods or procedures for each parameter identified in Table QAPjP-1 shall be selected or developed and approved before use to comply with appropriate Westinghouse Hanford procedures and/or procurement control requirements. Table QAPjP-1 contains minimum requirements that shall be considered minimum performance standards that shall be incorporated into the agreements for services established with all analytical laboratories.

Table QAPjP-3 provides the preservation technique, container, and holding time for each of the analytes of interest. The preservation technique should be initiated immediately after the sample is extracted. Holding time is based on the maximum amount of time allowable, if proper preservation techniques are applied, to analyze the sample before the validity of the data could be considered suspect. All analytical procedures approved for use in this investigation shall require the use of standard units to facilitate the comparability of data sets in terms of precision and accuracy. All approved procedures shall be retained in the project quality records and shall be available for review on request.

Table QAPjP-1 listed various methods for the analysis of parameters listed. Standard EPA approved methods for evaluating solid waste (i.e., *Test Methods for Evaluating Solid Wastes,* EPA 1986) will be used for analysis of the metals and organics. Geochemical and physical property testing will be conducted based on ASTM, or other nationally recognized consensus methods. All test methods shall be documented by the laboratory and submitted for Westinghouse Hanford approval prior to use. These tests shall be performed in accordance with QR 11.0, "Test Control" (WHC 1992a).

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 DATA REDUCTION AND DATA PACKAGE PREPARATION

All analytical laboratories shall be responsible for preparing a report summarizing the results of analysis and for preparing a detailed data package. The data package includes identifying samples, sampling and analysis dates, raw analytical data, reduced data, data outliers, reduction formulas, recovery percentages, quality control check data, equipment calibration data, supporting chromatogram or spectrograms, and documentation of any nonconformances affecting the measurement system in use during the analysis of the particular group of samples. Data reduction schemes shall be contained within individual laboratory analytical methods and/or QA manuals, submitted for Westinghouse Hanford review and approval as discussed in Section 4.1. The completed data package shall be reviewed and approved by the analytical laboratory's QA manager (or field team leader for field screening type analysis) before its submittal to the Westinghouse Hanford Technical Lead. Completed data packages shall be submitted to the OSM for tracking and data validation functions. All data packages shall be verified; the percentage of data packages requiring fill validation will be established based on the end use of the data. The requirements of this section shall be included in procurement documentation or work orders, as appropriate, to comply with the standard Westinghouse Hanford procurement control procedures noted in Section 4.1.

8.2 VALIDATION

Validation of the completed data package will be performed by qualified Westinghouse Hanford OSM personnel or by a qualified independent contractor. Subcontracted validation responsibilities shall be defined in procurement documentation or work orders as appropriate. All validation shall be performed in compliance with the *Sample Management and Administration Manual* (WHC 1990b) Section 2.1 for inorganics analyses, Section 2.2, for organics analyses, and Sections 2.3 and 2.4 for radionuclide analysis.

8.3 FINAL REVIEW AND RECORDS MANAGEMENT CONSIDERATIONS

All validation reports and supporting analytical data packages shall be subject to a final technical review by a qualified reviewer at the direction of the Westinghouse Hanford Technical Lead, before their submittal to regulatory agencies or inclusion in reports or technical memoranda. All validation reports, data packages, and review comments shall be retained as permanent project quality records in compliance with the *Document Control and Records Management Manual* (WHC 1988c) requirements.

8.4 PROCESS FOR HANDLING UNACCEPTABLE OR SUSPECT DATA

The analytical data flow and data management process is described in detail in EII 14.1, "Analytical Laboratory Data Management" (WHC 1992b). Data errors or procedural discrepancies related to laboratory analytical processes shall prompt data requalification by the validator, requests for reanalysis, or other appropriate corrective action by the responsible laboratory as required by governing OSM or approved subcontractor data validation procedures. If sample holding time requirements are compromised, insufficient sample material is available for reanalysis, or any other condition prevents compliance with governing analytical methods and data validation protocols, the situation shall be formally documented as a nonconformance in compliance with QR 15.0, "Control of Nonconforming Items" (WHC 1992a). A corrective action request shall be prepared in compliance with requirements of QR 16.0, "Corrective Action" (WHC 1992a), and brought to the immediate attention of the Westinghouse Hanford Technical Lead and QA Coordinator for their appropriate action. If problems are observed with validated data, either as part of the data assessment process described in Section 12.0 of this QAPjP or if separately observed by the operable unit manager, the data shall be documented as a nonconformance and corrective action initiated as previously noted; if the data have been entered in the Hanford Environmental Information System (HEIS), the HEIS Data Custodian shall be immediately notified in order that the data may be flagged [in compliance with EII 14.1 and the *HEIS User's Manual* (WHC 1990c)] as suspect, pending resolution of the nonconformance and completion of all required corrective actions.

9.0 INTERNAL QUALITY CONTROL

General procedures used in the field and laboratory to maintain data quality include the following:

- Use of accepted sampling and analysis techniques
- Justification and documentation of any actions contrary to accepted or specified techniques
- Documentation of pre-field activities, such as container preparation and instrument calibration
- Documentation of post-field activities including sample shipment and receipt, equipment check-in, and debriefing
- Documentation of quality control data
- Documentation of field and laboratory activities, and
- Generation of quality control samples.

All analytical samples shall be subject to in-process quality control measures in both the field and laboratory. Internal quality control checks for reference method analysis shall be as specified by the current statement of work, or work orders for sampling activities or in applicable EIIs and the number of quality control samples are shown in Table QAPjP-4.

9.1 FIELD QUALITY CONTROL CHECKS

The number of field QC samples specified in Table QAPjP-4 are based on the following minimum requirements. These requirements are adapted from *Test Methods for Evaluating Solid Waste* (EPA 1986), as modified by the proposed rule changes included in the *Federal Register*, 1989, Volume 54, No. 13, pp 3212-3228, and 1990, Volume 55, No. 27, pp 4440-4445.

- <u>Field duplicate samples</u>. For each shift of sampling activity under an individual sampling subtask, a minimum of 5% of the total collected samples shall be duplicated, or one duplicate shall be collected for every 20 samples, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique, and shall be placed into two identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of gross errors in sampling techniques.

- Split samples. Upon specific Westinghouse Hanford or regulator request, and at the technical lead's direction, field or field duplicate samples may be split in the field and sent to an alternative laboratory as a performance audit of the primary laboratory. Frequency shall meet the minimum schedule requirements for audit procedures or the specific needs of the requesting organization.

- Blind samples. At the technical lead's discretion, blind reference samples may be introduced into any sampling round as a quality control check of the primary laboratory. Blind sample type shall be as directed by the Technical Lead; frequency shall meet the minimum schedule requirements for audit procedures.

- Field blanks. Field blanks shall consist of pure deionized distilled water, transferred into a sample container at the site and preserved with the reagent specified for the analytes of interest. Field blanks are used as a check on reagent and environmental contamination, and shall be collected at the same frequency as field duplicate samples.

- Equipment rinsate blanks. Equipment blanks shall consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures, and shall be collected at the same frequency as field duplicate samples where applicable.

- Volatile organic analysis trip blanks. The volatile organic analysis (VOA) trip blanks consist of pure deionized distilled water added to one clean sample container, accompanying each batch (cooler) of containers shipped to the sampling facility. Trip blanks shall be returned unopened to the laboratory, and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage or site conditions. The trip blank shall be analyzed for volatile organic compounds only, as shown on EPA's target compound list (TCL; EPA 1991). In compliance with standard Westinghouse Hanford procurement procedures, requirements for trip blank preparation shall be included in procurement documents of work orders to the sample container supplier and/or preparer.

9.2 LABORATORY QUALITY CONTROL CHECKS

Laboratory quality control data are necessary to determine precision and accuracy of the analyses and to demonstrate the absence of interferences and contamination of glassware and reagents. Unless otherwise specified in Westinghouse Hanford-approved analytical methods, internal quality control checks performed by analytical laboratories shall meet the following minimum requirements.

- Matrix-spike/matrix-spike duplicate samples. Matrix-spiked samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage and as a test of analytical precision. The spike shall be made in a replicate of a field duplicate sample. Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations shall be described in the analytical procedures submitted for Westinghouse Hanford review and approval. One sample shall be spiked per analytical batch, or once every 20 samples, whichever is more frequent.

- Quality control reference samples. A quality control reference sample shall be prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples are required as an independent check on analytical technique and methodology, and shall be run with every analytical batch, or every 20 samples, whichever is more frequent.

Other requirements specific to laboratory analytical equipment calibration are included in Section 6.0 of this QAPjP. For field screening gas chromatography (GC) analysis, at least one duplicate sample per shift shall be routed to a qualified laboratory as an overcheck on the proper use and functioning of field GC procedures and equipment. Duplicates shall be selected, whenever possible, from samples in which significant readings have been observed during field analysis. The minimum requirements of this section shall be invoked in procurement documents or work orders in compliance with standard Westinghouse Hanford procedures as noted in Section 4.1.

10.0 PERFORMANCE AND SYSTEM AUDITS

Systems audits consist of the evaluation of the components of the measurement systems to determine their proper selection and use. Systems audit requirements will be implemented according to the procedures in QI 10.4, "Surveillance" (WHC 1992a) and other associated procedures as identified in the QAPI in the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a).

After systems are operational and are generating data, performance audits will be conducted to ensure the accuracy of the total system or its individual parts. In a performance audit, known quantitative data are compared with data produced by the measurement system. Performance audits will be conducted in accordance with EII 1.12, "Performance Audits" (WHC 1992b).

Performance and systems audits will be performed regularly throughout the course of the activities addressed by the work plan; schedules shall be developed as required by their governing procedures. Additional surveillance may be scheduled as a consequence of corrective action requirements, or may be performed upon request. All quality-affecting activities are subject to surveillance. All aspects of inter-operable unit activities may also be evaluated as part of routine QA program audits, pursuant to the requirements of the *Quality Assurance Manual* (WHC 1992a). Program audits shall be conducted in accordance with QR 18.0, "Audits," (WHC 1992a).

Any discrepancies observed during the evaluation of performance audit results or during system audit surveillance activities that cannot be immediately corrected to the satisfaction of the investigator shall be documented on a surveillance report and resolved in compliance with procedure QI 10.4, "Surveillance" (WHC 1992a).

11.0 PREVENTIVE MAINTENANCE

All measurement and testing equipment used in the field and laboratories that directly affect the quality of the field and analytical data shall be subject to preventive maintenance measures that ensure minimization of measurement system downtime and corresponding schedule delays. Laboratories shall be responsible for performing or managing the maintenance of their analytical equipment. Maintenance requirements, spare parts lists and instructions shall be included in individual laboratory QA plans, subject to Westinghouse Hanford review and approval as noted in Sections 2.1, 2.2, and 4.1 of this QAPjP. Westinghouse Hanford field equipment shall be drawn from inventories subject to standard preventive maintenance and calibration procedures as noted under criterion 12 of the QAPI included in the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a). Field procedures submitted for Westinghouse Hanford approval by participant contractors or subcontractors shall contain provisions for preventive maintenance schedules and spare parts lists to ensure minimization of equipment downtime.

12.0 DATA MEASUREMENT ASSESSMENT PROCEDURES

As discussed in Section 5.0, various uncertainty may exist in the variability of physical and chemical parameters used in the data characterization. Various statistical and probabilistic techniques may be used in the process of data comparison and analysis. *Soil Sampling Quality Assurance User's Guide* (Barth and Mason 1984) provides statistical techniques necessary to numerically assess the statistical uncertainty considerations and quality control checks which shall be routinely assessed for all sampling data. *A Rationale for the Assessment of Errors in the Sampling of Soils* (Jeffrey and Blume 1989) also provides equations for estimating uncertainty of data. The statistical methodologies and assumptions to be used in such evaluations shall be defined by written directions that are signed, dated and retained as project records in compliance with EII 1.6, "Records Management" (WHC 1992b) and Section 9 of the *Document Control and Records Management Manual* (WHC 1988c).

13.0 CORRECTIVE ACTION

Corrective action requests required as a result of surveillance reports, nonconformance reports or audit activity shall be documented and dispositioned as required by QR 16.0, "Corrective Action;" (WHC 1992a). Other measurement systems procedure or plan corrections that may be required as a result of data assessment or routine review processes shall be resolved as required by governing procedures or shall be referred to the Technical Lead for resolution. Copies of all surveillance, nonconformance, audit and corrective action documentation shall be placed with the project quality records on completion or closure.

13.1 EQUIPMENT OPERATING RANGES

Instruments or equipment found to be operating outside acceptable operating ranges or found to be in use after the expiration of the calibration period must be investigated in accordance with the procedures specified in Section 6.0.

13.2 DEVIATIONS FROM PROCEDURES

Unplanned deviations from procedural requirements, either technical or administrative, must be documented and called to the attention of the Technical Lead. The report of the deviation must identify the requirement deviated from, the cause of the deviation, whether any data were affected, and the corrective action necessary to remedy the immediate problem and to prevent recurrence. Records of unplanned deviations must be maintained in accordance with EII 1.2, "Preparation and Revision of Environmental Investigations Instructions" (WHC 1992b) and Section 9 of the *Document Control and Records Management Manual* (WHC 1988c). Planned deviations will be handled in accordance with EII 1.4, "Instruction Change Authorizations" (WHC 1992b).

13.3 NONCONFORMING MATERIALS

Materials that do not conform to specifications must be handled as required by QR 15.0, "Control of Nonconforming Items" (WHC 1992a), and other procedures as identified under criterion 15 of the QAPI included in the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a). Such nonconforming items must be segregated and tagged to identify their status pending disposition.

14.0 QUALITY ASSURANCE REPORTS

As previously stated in Sections 10.0 and 13.0, project activities shall be regularly assessed by performance and system auditing and associated corrective action processes. Surveillance, nonconformance, audit and corrective action documentation shall be routed to the project quality records on completion or closure of the activity. A report summarizing all audit and surveillance activity (see Sections 4.4 and 13.2), and any associated corrective actions, shall be prepared by the Technical Lead by the QA Coordinator at the completion of the investigation. Such information will become an integral part of the final LFI report prepared under Task 10 (see Section 5.0). The final report shall include an assessment of the overall adequacy of the total measurement system with regard to the DQOs of the investigation.

15.0 REFERENCES

Barth, D.S. and B.J. Mason, 1984, *Soil Sampling Quality Assurance User's Guide;* U.S. Environmental Protection Agency, Office of Research and Development, Las Vegas, NV. EPA 600/4-84-043.

EPA, 1986, *Test Methods for Evaluating Solid Waste*, Third Edition, SW-846, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1991, *USEPA Contract Laboratory Program Statement of Work for Organics Analysis: Multi-Media Multi-Concentration*, U.S. Environmental Protection Agency, Sample Management Laboratory, Washington, D.C.

Jeffrey, Van Ee, J. and Louise J. Blume, 1989, *A Rationale for the Assessment of Errors in the Sampling of Soils*, EPA/600/R-09/203; U.S. Environmental Protection Agency, Research and Development Systems Laboratory, Las Vegas, NV.

Klute, A. (ed.), 1986, *Methods of Soil Analysis, Part I,* American Society of Agronomy, Madison, Wisconsin.

Kopp, J.F., and G.D. McKee, 1983, *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Washington, D.C.

Krieger, H.L., and E.L. Whittaker, 1980, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA/600/4-80/032, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

Page, A.L., R.H. Miller, and D.R. Keeney, 1982, *Method of Soil Analysis: Part 2 - Chemical and Microbiological Properties*, American Society of Agronomy, Inc., Madison, Wisconsin.

Lindahl, P.C., 1984, *Determination of Inorganic Anions in Aqueous and Solid Samples of Ion Chromatography*, EPA/600/4-84/017, Argonne National Laboratory, Argonne, Illinois.

Volchok, H.L. and G. dePlanque (editors), 1982, *EML Procedures Manual*, 25th edition, HASL-300-Ed.25, U.S. Department of Energy, Environmental Measurements Laboratory, New York, New York.

WHC 1988a, *Radiation Protection Manual,* WHC-CM-4-10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988b, *Management Requirements and Procedures Manual,* WHC-CM-1-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988c, *Document Control and Records Management Manual,* WHC-CM-3-5; Westinghouse Hanford Company, Richland, Washington.

WHC, 1990a, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan*, WHC-EP-0383, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990b, *Sample Management and Administration Manual*, WHC-CM-5-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990c, *HEIS User's Manual,* WHC-EP-0372; Westinghouse Hanford Company, Richland, Washington.

WHC, 1992a, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992b, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992c, *Occupational Health Physics Practices Manual*, WHC-CM-4-12, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992d, *Base Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System,* WHC-EP-0276; Westinghouse Hanford Company, Richland, Washington.

Table QAPjP-1. Analytical Methods, Analytes of Interest, Quantitation Limits, and Precision and Accuracy Guidelines for the 200-UP-2 Source Operable Unit.

Parameter	Analytical Method	Target Quantitation Limit Soil[a]	Precision, Soil[b]	Accuracy, Soil[b]	Target Quantitation Limit Water[a]	Precision, Water[b]	Accuracy, Water[b]
Volatile Organics[j]	8240[c]	c	±35	75-125	c	±25	75-125
TCL Semivolatile organics[m]	8015[c]	c	±35	75-125	c	±25	75-125
TAL Inorganics							
Arsenic	7061[c]	c	±35	75-125	c	±20	75-125
Barium	6010[c]	c	±35	75-125	c	±20	75-125
Boron	6010[c]	c	±35	75-125	c	±20	75-125
Cadmium	6010[c]	c	±35	75-125	c	±20	75-125
Chromium	6010[c]	c	±35	75-125	c	±20	75-125
Copper	6010[c]	c	±35	75-125	c	±20	75-125
Iron	6010[c]	c	±35	75-125	c	±20	75-125
Lead	6010[c]	c	±35	75-125	c	±20	75-125
Manganese	6010[c]	c	±35	75-125	c	±20	75-125
Mercury	7471[c/e]/245.2[c/d]	c	±35	75-125	c	±20	75-125
Nickel	6010[c]	c	±35	75-125	c	±20	75-125
Selenium	7740[c]	c	±35	75-125	c	±20	75-125
Silver	6010[c]	c	±35	75-125	c	±20	75-125
Titanium	6010[c]	c	±35	75-125	c	±20	75-125
Vanadium	6010[c]	c	±35	75-125	c	±20	75-125
Zinc	6010[c]	c	±35	75-125	c	±20	75-125

Table QAPjP-1. Analytical Methods, Analytes of Interest, Quantitation Limits, and Precision and Accuracy Guidelines for the 200-UP-2 Source Operable Unit.

Parameter	Analytical Method	Target Quantitation Limit Soil[a/]	Precision, Soil[b/]	Accuracy, Soil[b/]	Target Quantitation Limit Water[a/]	Precision, Water[b/]	Accuracy, Water[b/]
Cyanide	9010[c/e/]/335.3[c/d/]	c	±35	75-125	c	±20	75-125
Fluoride	EPA 300/modified[g/] or 340.2[f/]	0.5 mg/kg	±35	75-125	100 μg/L	±20	75-125
Nitrate	EPA 300/modified[g/], 352.1[f/], 353.3[f/], 353.2[f/], or 354.1[f/]	1.0 mg/kg	±35	75-125	100 μg/L	±20	75-125
Nitrite	EPA 300/modified[g/], 352.1[f/], 353.3[f/], 353.2[f/], or 354.1[f/]	1.0 mg/kg	±35	75-125	100 μg/L	±20	75-125
Tritium	Water 906.0[h/] Soil[k/]	400 pCi/L	±35	75-125	400 pCi/L	±20	75-125
Gross Alpha	900.0 M	TBD	±30	±25	10	±25	±25
Gross Beta	900.0 M	TBD	±30	±25	5	±25	±25
Americium-241	Am-01[c/]/Am-03[d/]						
Americium-243	Am-01[c/]/Am-03[d/]	TBD	±30	±25	TBD	±25	±25
Antimony-126	D3649 M	TBD	±30	±25	TBD	±25	±25
Cesium-134	D3649 M	TBD	±30	±25	TBD	±25	±25
Cesium-137	D3649 M	TBD	±30	±25	TBD	±25	±25
Cobalt-60	D3649 M	TBD	±30	±25	TBD	±25	±25

Table QAPjP-1. Analytical Methods, Analytes of Interest, Quantitation Limits, and Precision and Accuracy Guidelines for the 200-UP-2 Source Operable Unit. Page 3 of 6

Parameter	Analytical Method	Target Quantitation Limit Soil[a/]	Precision, Soil[b/]	Accuracy, Soil[b/]	Target Quantitation Limit Water[a/]	Precision, Water[b/]	Accuracy, Water[b/]
Curium-244	907.0 M[c/]/ 907.0[d/]	TBD	±30	±25	TBD	±25	±25
Curium-245	907.0 M	TBD	±30	±25	TBD	±25	±25
Europium-152	D3649 M	TBD	±30	±25	TBD	±25	±25
Europium-154	D3649 M	TBD	±30	±25	TBD	±25	±25
Europium-155	D3649 M	TBD	±30	±25	TBD	±25	±25
Iodine-129	902.0 M[c/]/ 902.0[d/]	TBD	±30	±25	TBD	±25	±25
Neptunium-237	907.0 M[c/]/907.0[d/]	TBD	±30	±25	TBD	±25	±25
Neptunium-239	D3649 M	TBD	±30	±25	TBD	±25	±25
Plutonium-238	Pu-02[c/]/Pu-10[d/]	TBD	±30	±25	TBD	±25	±25
Plutonium-239/240	Pu-02[c/]/Pu-10[d/]	TBD	±30	±25	TBD	±25	±25
Potassium-40	D3649 M	TBD	±30	±25	TBD	±25	±25
Protactinium-231	D3649 M	TBD	±30	±25	TBD	±25	±25
Protactinium-234m	D3649 M	TBD	±30	±25	TBD	±25	±25
Ruthenium-106	D3649 M	TBD	±30	±25	TBD	±25	±25
Samarium-151	TBD	TBD	±30	±25	TBD	±25	±25
Selenium-79	TBD	TBD	±30	±25	TBD	±25	±25
Sodium-22	D3469 M	TBD	±30	±25	TBD	±25	±25
Thorium-227	00.06[c/]/00-07[d/]	TBD	±30	±25	TBD	±25	±25

Table QAPjP-1. Analytical Methods, Analytes of Interest, Quantitation Limits, and Precision and Accuracy Guidelines for the 200-UP-2 Source Operable Unit.

Parameter	Analytical Method	Target Quantitation Limit Soil[a]	Precision, Soil[b]	Accuracy, Soil[b]	Target Quantitation Limit Water[a]	Precision, Water[b]	Accuracy, Water[b]
Thorium-229	00.06[c]/00-07[d]	TBD	±30	±25	TBD	±25	±25
Thorium-231	D3649 M	TBD	±30	±25	TBD	±25	±25
Tritium	906.0	TBD	±30	±25	TBD	±25	±25
Uranium-233	U[c]/908.0[d]	TBD	±30	±25	TBD	±25	±25
Uranium-234	U[c]/908.0[d]	TBD	±30	±25	TBD	±25	±25
Uranium-235/236	U[c]/908.0[d]	TBD	±30	±25	TBD	±25	±25
Uranium-238	U[c]/908.0[d]	TBD	±30	±25	TBD	±25	±25
Zirconium-93	TBD	TBD	±30	±25	TBD	±25	±25
Boron	6010	TBD	±25	±30	TBD	±20	±25
Carbon-14	C-01	TBD	±30	±25	TBD	±25	±25
Strontium-90	Sr-02	TBD	±30	±25	TBD	±25	±25
Technetium-99	TC-01 M[c]/ TC-01[k]	TBD	±30	±25	TBD	±25	±25
Gross alpha	Water 900[h] Soil 900.0M[k]	1pCi/g	±35	75-125	3pCi/L	±20	75-125
Gross beta	Water 900[h] Soil 900.0 M[k]	4 pCi/g	±35	75-125	4 pCi/L	±20	75-125
Groundwater Parameters							
Alkalinity	310.1[f]	NA	NA	NA	10,000 µg/L	±20	75-125
Chemical Oxygen Demand	410.1[f]	NA	NA	NA	1,000 µg/L	±20	NA

Table QAPjP-1. Analytical Methods, Analytes of Interest, Quantitation Limits, and Precision and Accuracy Guidelines for the 200-UP-2 Source Operable Unit.

Parameter	Analytical Method	Target Quantitation Limit Soil[a/]	Precision, Soil[b/]	Accuracy, Soil[b/]	Target Quantitation Limit Water[a/]	Precision, Water[b/]	Accuracy, Water[b/]
Specific Conductance	[i/]	NA	NA	NA	25 μmhos/cm	±20	NA
pH	[i/]	NA	NA	NA	NA	NA	NA
Temperature	[i/]	NA	NA	NA	NA	±1°C	NA
Dissolved Oxygen	360.1[f/]	NA	NA	NA	100 μg/L	±20	NA
Total Disolved Solids	160.1[f/]	NA	NA	NA	10,000 μg/L	±20	NA
Total Organic Carbon	415.1[f/]	NA	NA	NA	1,000 μg/L	±20	75-125
Total Oganic Halides	9020[g/]	NA	NA	NA	5 μg/L	±20	75-125
Turbidity	180.1[f/]	NA	NA	NA	0.05 NTU	±.05 NTU	NA
Soil Physical and Chemical Properties	--	NA	NA	NA	NA	NA	NA
Bulk Density	ASTM D3550-87	--	--	--	--	--	--
Particle Size Distribution	ASTM D433	--	--	--	--	--	--
Moisture Content	ASTM D2216-90	--	--	--	--	--	--
$CaCO_3$ Content	ASTM D4373	--	--	--	--	--	--
Saturated Hydraulic Conductivity	ASTM D5084						
Unsaturated Hydraulic Conductivity	--	--	--	--	--	--	--
Matric Potential and Soil Moisture Retention Curves	ASTM D2325-68, D3152-72	--	--	--	--	--	--

Table QAPjP-1. Analytical Methods, Analytes of Interest, Quantitation Limits, and Precision and Accuracy Guidelines for the 200-UP-2 Source Operable Unit. Page 6 of 6

Parameter	Analytical Method	Target Quantitation Limit Soil[a]	Precision, Soil[b]	Accuracy, Soil[b]	Target Quantitation Limit Water[a]	Precision, Water[b]	Accuracy, Water[b]
Particle Density	ASTM D854	--	--	--	--	--	--
Cation Exchange Capacity	SW 846 9081	--	--	--	--	--	--
Organic Carbon Content	SW 846 9060	--	--	--	--	--	--
Iron and Manganese Content	--	--	--	--	--	--	--
pH and if possible Eh	ASTM G51, SW 846 9050	--	--	--	--	--	--
Minerology	--	--	--	--	--	--	--

[a] Values are to be considered requirements in the absence of known or suspected analytical interferences which may hinder achieving the limit by the analytical laboratory.

[b] Precision is expressed as relative percent difference; accuracy is expressed as percent recovery. These limits apply to sample results greater than five times the target quantitation limit and are to be considered requirements in the absence of known or suspected analytical interferences which may hinder achieving the limit by the analytical laboratory.

[c] Methods specified from *Test Methods for Evaluating Solid Waste* (EPA 1986).

[d] Water analysis.

[e] Soil analysis.

[f] Methods specified from *Methods for Chemical Analysis of Water and Wastes* (Kopp and McKee 1983).

[g] Method is from *Determination of Inorganic Anions in Aqueous and Solid Samples by Ion Chromatography* (Lindahl 1984) and is modified from EPA method 300.0.

[h] Methods from *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (Krieger and Whittaker 1980) or an equivalent method.

[i] Methods, quantitation limits, and target values for precision and accuracy shall be developed in compliance with Westinghouse Hanford or Westinghouse Hanford-approved participant contractor or subcontractor procedures.

[j] At a minimum: acetone, carbon tetrachloride, chloroform, methylene chloride, MIBK, toluene, and 1,1,1-trichlorethane will be tested for.

[k] Applicable methods shall be selected from the *EML Procedures Manual* (Volchok and dePlanque 1982) or an equivalent method.

[l] Parameter measured in the field in compliance with EII 5.8, "Groundwater Sampling."

[m] At a minimum: kerosene and tributyl phosphaste will be tested for.

Table QAPjP-2. Sampling and Investigative Procedures for Field Investigations.

Procedure Title or Subject[a]	Task Number			
	2	3	4	5
EII 1.1 Hazardous waste site entry requirements	X	X	X	--
EII 1.2 Preparation and revision of environmental investigations and instructions	X	X	X	X
EII 1.4 Instruction Change Authorizations	X	X	X	X
EII 1.5 Field logbooks	X	X	--	--
EII 1.6, WHC-CM-5-3 Records management	X	X	X	X
EII 1.7 Indoctrination, training, and qualification	X	X	X	X
EII 1.11 Technical data management	X	X	X	X
EII 1.12 Performance audits	X	X	X	X
EII 2.1 Preparation of hazardous waste operations permits	X	X	X	--
EII 2.2 Occupational health monitoring	X	X	X	--
WHC-CM-4-12 Health physics practices manual	X	X	X	--
EII 2.3 Administration of radiation surveys to support environmental characterization work on the Hanford Site	X	--	--	X
EII 3.2 Health and safety monitoring instruments	X	--	X	X
EII 3.4 Field screening	X	--	X	X
EII 4.2 Interim control of unknown, suspected hazardous and mixed waste	X	X	X	--
EII 4.3 Control of CERCLA and other past-practice investigation derived waste	X	--	X	X
EII 5.1 Chain of custody	X	--	X	X
EII 5.2 Soil and sediment sampling	X	X	--	--
EII 5.4 Field decontamination of drilling, well development, and sampling equipment	--	--	--	X
EII 5.5 1706 KE laboratory decontamination of RCRA/CERCLA sampling equipment	X	--	X	X
EII 5.7A Hanford geotechnical library control, sample identification and data entry into HEIS data base	--	--	--	--

Table QAPjP-2. Sampling and Investigative Procedures for Field Investigations. Page 2 of 2

Procedure Title or Subject[a]	Task Number 2	3	4	5
EII 5.8 Groundwater Sampling	X	--	--	X
EII 5.9 Soil-Gas Sampling	X	--	--	--
EII 5.10 Obtaining sample identification numbers and accessing HEIS data	X	--	X	X
EII 5.11 Sample packaging and shipping	X	--	X	X
EII 6.1 Activity reports of field operations	X	X	X	X
EII 6.7 Resource protection well and test borehole drilling	--	--	--	X
EII 6.10 Abandoning/Decommissioning groundwater wells	X	--	--	--
EII 8.1 Verification and reclamation of boreholes	X	--	--	--
EII 9.1 Geologic logging	--	--	--	X
WHC-CM-5-7, Sec 4.3, Scintillation logging	X	--	--	--
EII 10.2 Measurement of groundwater levels	--	--	--	X
EII 10.3 Purgewater Management	--	--	--	X
EII 11.1 Geophysical logging	X	--	--	--
EII 11.2 Geophysical survey work	--	--	--	X

[a] Procedures are latest version of Westinghouse Hanford Environmental Investigations Instructions (EII) selected from the *Environmental Investigations and Site Characterization Manual* (WHC 1992b) unless otherwise specified.

Table QAPjP-3. Required Preservation, Container, and Holding Times.

Parameter	Preservation	Container	Holding Times
Total Extractable Petroleum Hydrocarbons	Cool to 4 °C;	Glass, Teflon-lined Cap	7 days for extraction, then 40 days for analysis
Volatile Organics	Cool to 4 °C; Water Samples: Adjust to $pH<2$ with HCl	Glass, Teflon-lined Cap	14 days
Metals	Cool to 4 °C; Water Samples: Adjust to $pH<2$ with HNO_3	Polyethylene or Glass	Acid digestion within 1 month and analysis within 6 months of sample collection
Mercury	Cool to 4 °C; Water Samples: Adjust to $pH<2$ with HNO_3	Polyethylene or Glass	28 days
Cyanide, Total	Cool to 4 °C; Water Samples: Adjust to $pH>12$ with NaOH	Polyethylene or Glass	14 days
Total Fluoride	Cool to 4 °C	Polyethylene	28 days
Radionuclides	--	Polyethylene	6 months
Nitrate/Nitrite	Cool to 4 °C	Glass	28 days
Tributyl Phosphate	Cool to 4 °C; water samples: Adjust to $pH<2$	Glass, Teflon Lined Cap	14 days

Table QAPjP-4. Quality Assurance Control Samples.

Parameters	Field[a] Samples	Duplicate Sample	Field and Equipment Rinsate Blanks	Trip Blank	MS/MSD[b]
Physical Properties - Type A[c]	55	6	NA	NA	NA
Physical Properties - Type B[d]	18	2	NA	NA	NA
Organics, Inorganics, and Rad	121	12	12	TBD	TBD

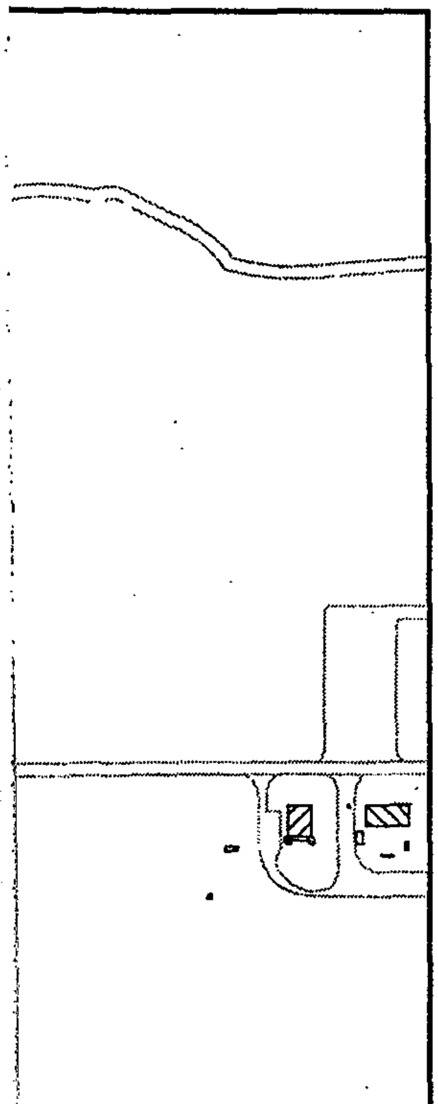
a/ Approximate number of field samples.
b/ Matrix spike/matrix spike duplicates are described in Section 9.2 of the QAPjP; one sample per analytical batch or one in every 10 samples shall be analyzed.
c/ Type A samples will be run for the following analyses: moisture content, bulk density, particle-size distribution, and $CaCO_3$ (samples from the test pits will not be run for bulk density).
d/ Type B samples will be run for Type A analyses: saturated hydraulic conductivity, cation exchange capacity, moisture retention curves, organic carbon content, iron and manganese content, pH, and if possible, Eh and mineralogy.

Table QAPjP-5. Soil Physical Parameters for the 200-UP-2 Source Operable Unit.

Parameter	ASTM or Other Standard Method
Bulk density	[a/]
Particle size distribution	D-422[b/]
Permeability	D-2434[b/]
Moisture content	D-2216[b/]

[a/] Method shall be developed by the laboratory contractor and submitted for Westinghouse Hanford review and approval before use.

[b/] Method is from the *1991 Annual Book of ASTM Standards* (ASTM 1991).



DRAFT

Westinghouse Hanford Company
200-UP-2 WORK PLAN

0023056